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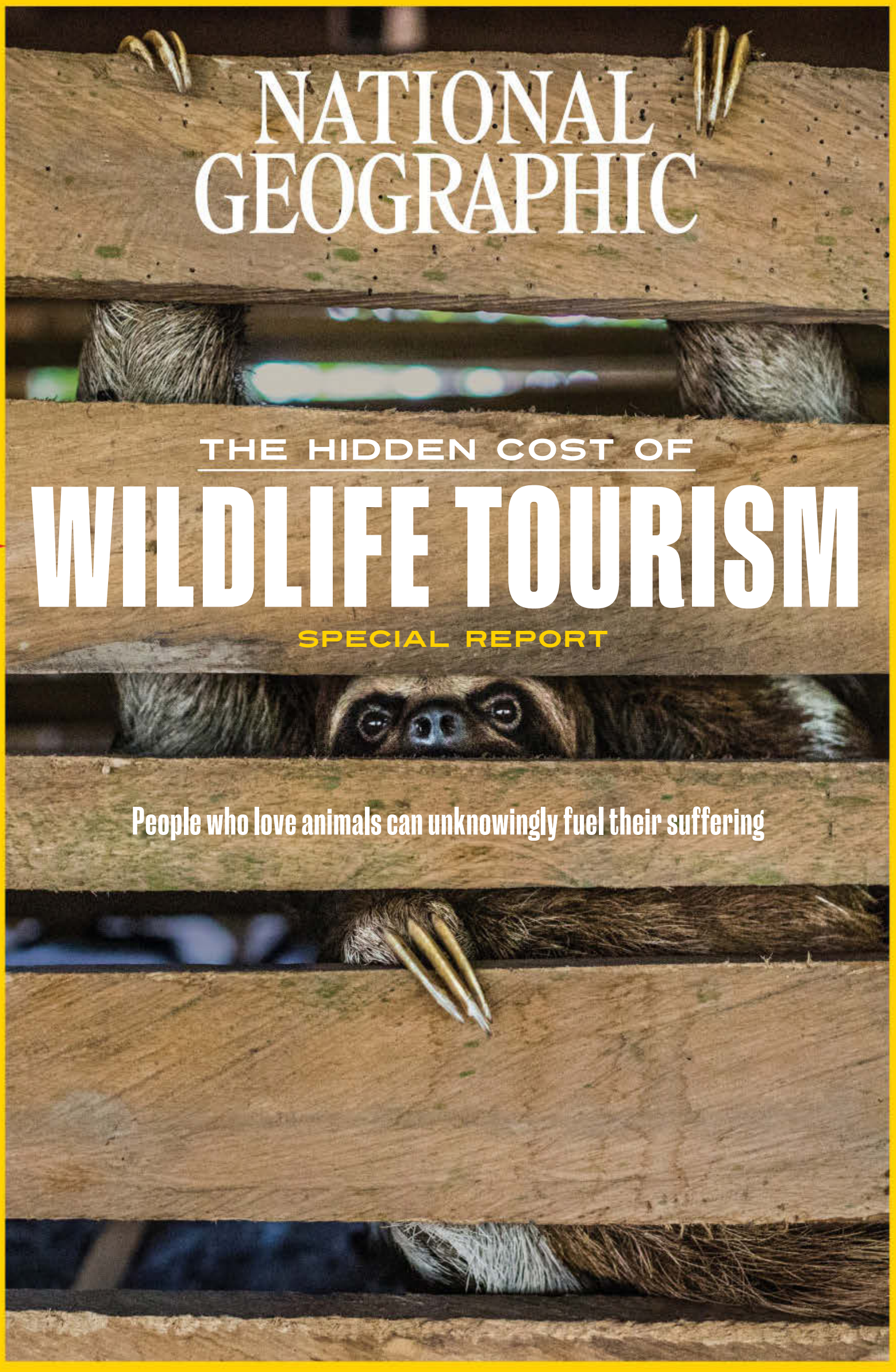
NATIONAL GEOGRAPHIC
THE HIDDEN COST OF
WILDLIFE TOURISM
SPECIAL REPORT
People who love animals can unknowingly fuel their suffering

BIG NEWS: FAST PAIN RELIEF IS NOW MIGHTY SMALL

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We made this product specifically for vegans and non-vegans and for normally-not-vegan-but-sometimes-flexi-veggie-person-tarians.

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THE POWER OF CLEAN

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P&G, the maker of Tide, Dawn and Pampers, has been transforming lives through its non-profit Children's Safe Drinking Water Program since 2004. Learn more at **NationalGeographic.com/PGWaterChampions.**

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NAT GEO TV

See how heroism held back Ebola in *The Hot Zone*

When the deadly Ebola virus was found in monkeys at a Virginia research lab in 1989, U.S. Army scientist Nancy Jaax put her life on the line to prevent its spread. Actress Julianna Margulies (above) plays Jaax in *The Hot Zone,* a television miniseries based on Richard Preston's best-selling book that tracks the virus from its origins in central Africa. The six-part series will air two episodes a night, starting at 9/8c, on May 27, 28, and 29 on National Geographic.

BOOKS

New Nat Geo *Kids Almanac* for 2020

To celebrate the 10th anniversary of the best-selling *National Geographic Kids Almanac,* the 2020 edition is packed with new content: photos, fun facts, activities, and more. Available wherever books are sold and at *shopng.com/books*.

NAT GEO WILD

Season two of *Secrets of the Zoo*

Go behind the scenes to meet the Columbus Zoo and Aquarium's army of caregivers, working 24/7 to create one of America's best zoo experiences. The new season of *Secrets of the Zoo* premieres June 2 at 9/8c on Nat Geo WILD.

TELEVISION

Honoring the D-Day anniversary

Commemorate the 75th anniversary of the Allied invasion with a week of special programming. Up first: a tour of underwater D-Day wrecks on the series *Drain the Ocean,* on June 3 at 9/8c on National Geographic.

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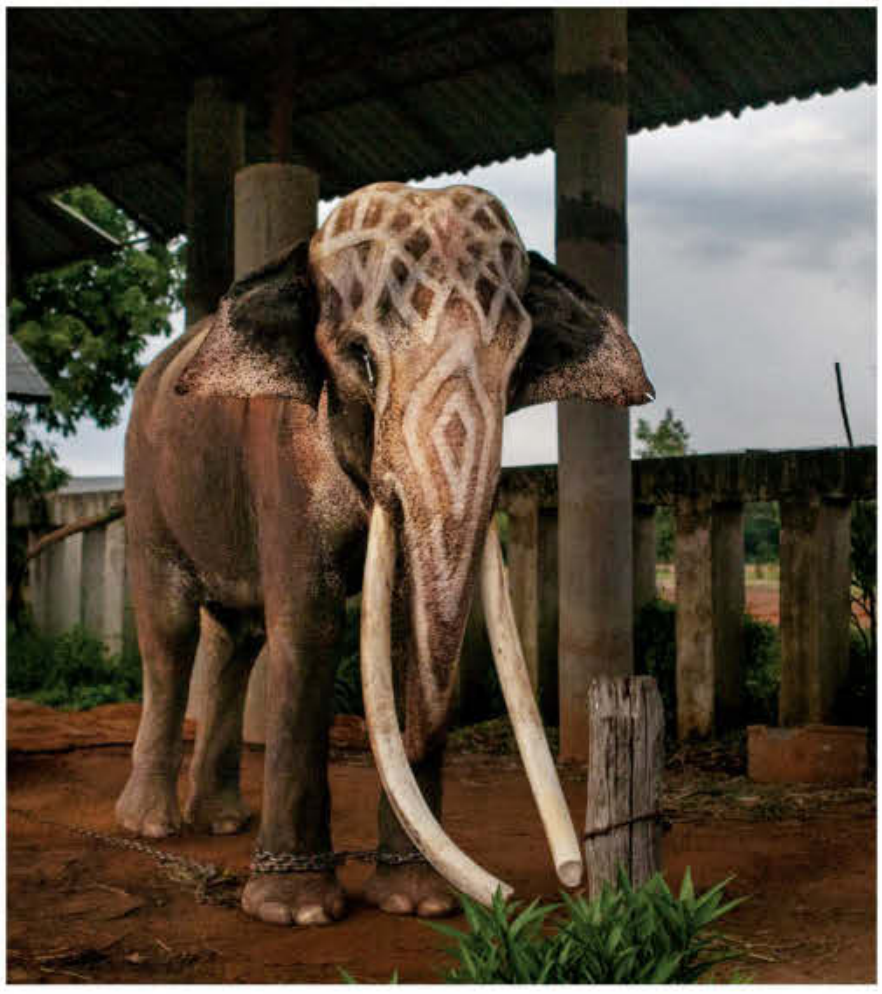
WILDLIFE WATCH

Exploiting Animals

BY **SUSAN GOLDBERG** PHOTOGRAPH BY **KIRSTEN LUCE**



Plai Thong Bai is about a half century old and famous in Thailand from Chang beer commercials. When rented out for festivals or parties, he's often painted with designs, some still visible above. In the enclosure where he lives, a chain hobbles his front legs.

Support the investigative journalism of Wildlife Watch by donating to the National Geographic Society's Illegal Wildlife Trade project: *donate.ngs.org/wildlife-watch*

PEOPLE LOVE ANIMALS. Nowhere is that more apparent than at National Geographic, where photos of animals are among the most "liked" by our Instagram followers, stories about animals drive traffic on our website, and animals are prominent in the pages of our magazine.

But this love of animals can often lead people, unwittingly, to hurt them. This month we explore the thriving industry of wildlife tourism—a way for people to appreciate and support animals when it's done appropriately but an exploitative business with terrible consequences when it's not.

We sent reporter Natasha Daly and photographer Kirsten Luce around the world to investigate the lives of captive animals once the selfie-taking tourists go home. What they found will break your heart. In some attractions with unscrupulous operators, tourists have no idea the animals they're joyously interacting with have been abused. They "don't know that ... the elephants give rides and perform tricks without harming people only because they've been 'broken' as babies," Daly writes. "Or that the Amazonian sloths taken illegally from the jungle often die within weeks of being in captivity."

Even more shocking is her discovery that some elephants at an "eco" resort in Thailand—where customers see animals roaming a property unchained—are the same elephants that, at another attraction just a few miles away, give rides and do tricks, sometimes prodded by a sharp metal hook.

Wildlife-encounter tourism is not new. But examining it is all the more urgent today because of social media. Who among us would not want to cuddle a baby tiger, memorialized by a shareable photo? That is, until we find out the reality: Cubs are taken from their mothers days after birth, so the mothers can quickly be bred again. And no one quite knows what happens to those precious baby tigers once they become unruly teenagers.

As our reporting found, too often this industry takes advantage of people's love of animals even as it exploits them for profit from birth to death.

With this month's package of stories on animal welfare and continuing coverage by our Wildlife Watch team, we hope this complicated, important topic gets the attention it deserves. That's the first step toward securing a truly happy ending for the animals.

Thank you for reading *National Geographic*.

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KEYTRUDA immunotherapy + chemotherapy (pemetrexed and a platinum) for advanced nonsquamous, non–small cell lung cancer that does not have an abnormal EGFR or ALK gene.

"TREATMENTS LIKE KEYTRUDA WITH CHEMOTHERAPY REALLY BREAK THROUGH BARRIERS WE HAD NOT LONG AGO."

—DR. GOETZ KLOECKER

KEYTRUDA will not work for everyone. Results may vary.

A clinical trial compared patients with advanced nonsquamous, non–small cell lung cancer (NSCLC) who received KEYTRUDA in combination with chemotherapy (410 patients) with those who received chemotherapy alone (206 patients). Patients in the trial did not have an abnormal EGFR or ALK gene and had no previous drug treatment.

WHEN TREATED WITH A COMBINATION OF KEYTRUDA AND CHEMOTHERAPY:

MORE PATIENTS LIVED LONGER

69% of patients taking KEYTRUDA with chemotherapy were alive compared with 48% taking chemotherapy alone.

MORE PATIENTS SAW THEIR TUMORS SHRINK

48% of patients taking KEYTRUDA with chemotherapy saw their tumors shrink compared with 19% taking chemotherapy alone.

The median duration of response to treatment was 11.2 months for patients treated with a combination of KEYTRUDA and chemotherapy compared with 7.8 months for those on chemotherapy alone.

KEYTRUDA is a prescription medicine used to treat a kind of lung cancer called NSCLC. KEYTRUDA may be used with the chemotherapy medicines pemetrexed and a platinum as your first treatment when your lung cancer has spread (advanced NSCLC) **and** is a type called "nonsquamous" **and** your tumor does not have an abnormal "EGFR" or "ALK" gene.

EGFR = epidermal growth factor receptor; ALK = anaplastic lymphoma kinase.

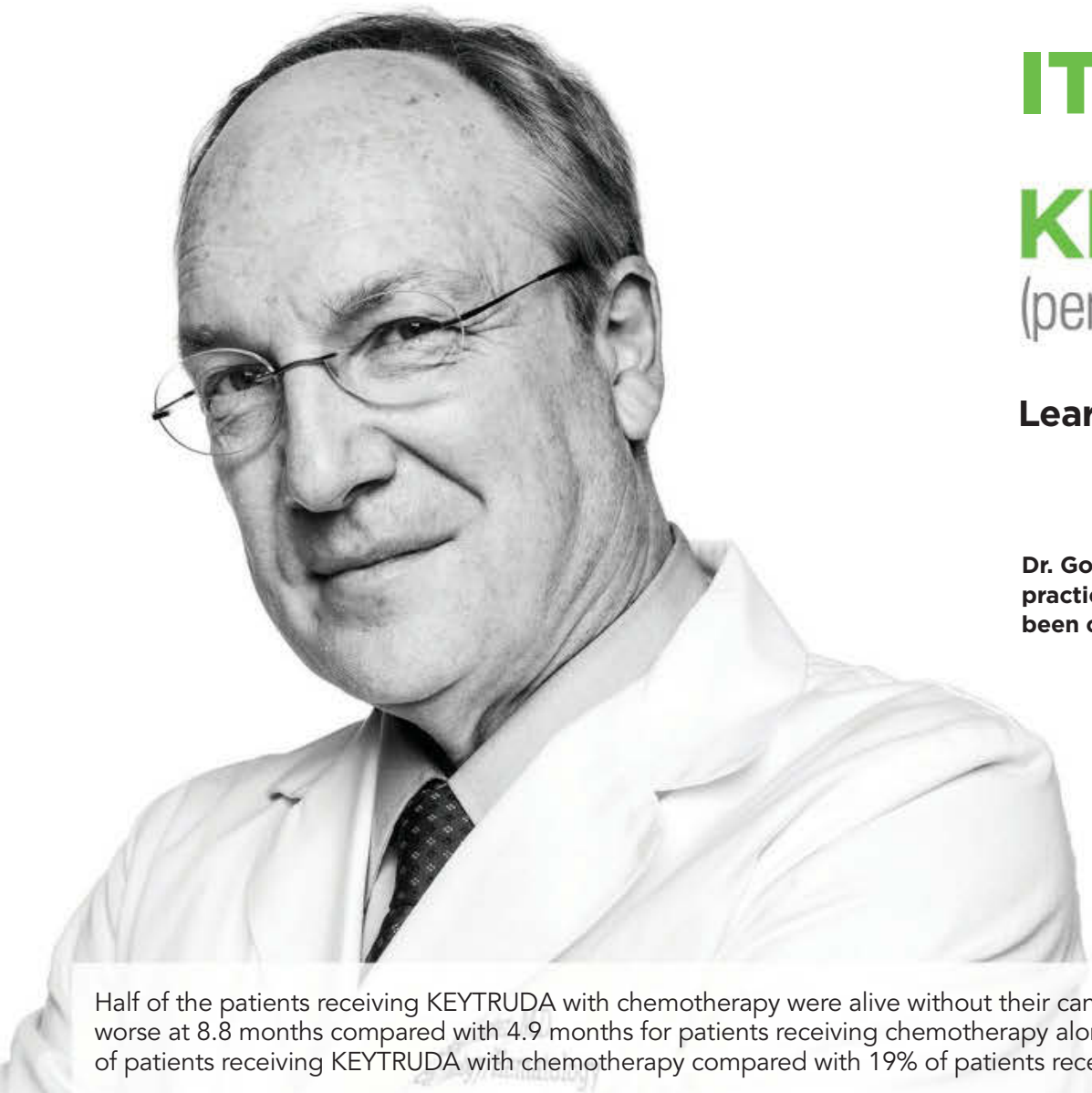
IMPORTANT SAFETY INFORMATION

KEYTRUDA is a medicine that may treat certain cancers by working with your immune system. KEYTRUDA can cause your immune system to attack normal organs and tissues in any area of your body and can affect the way they work. These problems can sometimes become severe or life-threatening and can lead to death. These problems may happen any time during treatment or even after your treatment has ended.

Call or see your doctor right away if you develop any symptoms of the following problems or these symptoms get worse:

- **Lung problems (pneumonitis).** Symptoms of pneumonitis may include shortness of breath, chest pain, or new or worse cough.
- **Intestinal problems (colitis) that can lead to tears or holes in your intestine.** Signs and symptoms of colitis may include diarrhea or more bowel movements than usual; stools that are black, tarry, sticky, or have blood or mucus; or severe stomach-area (abdomen) pain or tenderness.
- **Liver problems (hepatitis).** Signs and symptoms of hepatitis may include yellowing of your skin or the whites of your eyes, nausea or vomiting, pain on the right side of your stomach area (abdomen), dark urine, feeling less hungry than usual, or bleeding or bruising more easily than normal.
- **Hormone gland problems (especially the thyroid, pituitary, adrenal glands, and pancreas).** Signs and symptoms that your hormone glands are not working properly may include rapid heartbeat, weight loss or weight gain, increased sweating, feeling more hungry or thirsty, urinating more often than usual, hair loss, feeling cold, constipation, your voice gets deeper, muscle aches, dizziness or fainting, or headaches that will not go away or unusual headache.
- **Kidney problems, including nephritis and kidney failure.** Signs of kidney problems may include change in the amount or color of your urine.
- **Skin problems.** Signs of skin problems may include rash, itching, blisters, peeling or skin sores, or painful sores or ulcers in your mouth or in your nose, throat, or genital area.
- **Problems in other organs.** Signs and symptoms of these problems may include changes in eyesight; severe or persistent muscle or joint pains; severe muscle weakness; low red blood cells (anemia); swollen lymph nodes, rash or tender lumps on skin, cough, shortness of breath, vision changes, or eye pain (sarcoidosis); confusion, fever, muscle weakness, balance problems, nausea, vomiting, stiff neck, memory problems, or seizures (encephalitis); and shortness of breath, irregular heartbeat, feeling tired, or chest pain (myocarditis).
- **Infusion (IV) reactions that can sometimes be severe and life-threatening.** Signs and symptoms of infusion reactions may include chills or shaking, shortness of breath or wheezing, itching or rash, flushing, dizziness, fever, or feeling like passing out.

Important Safety Information is continued on the next page.



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(pembrolizumab) Injection 100 mg

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Dr. Goetz Kloecker is a practicing oncologist and has been compensated for his time.

Half of the patients receiving KEYTRUDA with chemotherapy were alive without their cancer spreading, growing, or getting worse at 8.8 months compared with 4.9 months for patients receiving chemotherapy alone. Cancer did not progress in 40% of patients receiving KEYTRUDA with chemotherapy compared with 19% of patients receiving chemotherapy alone.

The immunotherapy with the most FDA-approved uses for advanced lung cancer

IMPORTANT SAFETY INFORMATION *(continued)*

- **Rejection of a transplanted organ.** People who have had an organ transplant may have an increased risk of organ transplant rejection if they are treated with KEYTRUDA.
- **Complications, including graft-versus-host disease (GVHD), in people who have received a bone marrow (stem cell) transplant that uses donor stem cells (allogeneic).** These complications can be severe and can lead to death. These complications may happen if you underwent transplantation either before or after being treated with KEYTRUDA. Your doctor will monitor you for the following signs and symptoms: skin rash, liver inflammation, abdominal pain, and diarrhea.

Getting medical treatment right away may help keep these problems from becoming more serious. Your doctor will check you for these problems during treatment with KEYTRUDA. Your doctor may treat you with corticosteroid or hormone replacement medicines. Your doctor may also need to delay or completely stop treatment with KEYTRUDA if you have severe side effects.

Before you receive KEYTRUDA, tell your doctor if you have immune system problems such as Crohn's disease, ulcerative colitis, or lupus; have had an organ transplant or plan to have or have had a bone marrow (stem cell) transplant that used donor stem cells (allogeneic); have lung or breathing problems; have liver problems; or have any other medical problems. If you are pregnant or plan to become pregnant, tell your doctor. KEYTRUDA can harm your unborn baby. If you are able to become pregnant, your doctor will give you a pregnancy test before you start treatment. Use effective birth control during treatment and for at least 4 months after the final dose of KEYTRUDA. Tell your doctor right away if you think you may be pregnant or you become pregnant during treatment with KEYTRUDA.

If you are breastfeeding or plan to breastfeed, tell your doctor. It is not known if KEYTRUDA passes into your breast milk. Do not breastfeed during treatment with KEYTRUDA and for 4 months after your final dose of KEYTRUDA.

Tell your doctor about all the medicines you take, including prescription and over-the-counter medicines, vitamins, and herbal supplements.

Common side effects of KEYTRUDA when given with certain chemotherapy medicines include: feeling tired or weak, nausea, constipation, diarrhea, decreased appetite, rash, vomiting, cough, trouble breathing, fever, hair loss, and inflammation of the nerves that may cause pain, weakness, and paralysis in the arms and legs.

These are not all the possible side effects of KEYTRUDA. Tell your doctor if you have any side effect that bothers you or that does not go away. For more information, ask your doctor or pharmacist.

Please read the adjacent Important Information About KEYTRUDA and discuss it with your oncologist.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088.

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Important Information About KEYTRUDA® (pembrolizumab) injection 100 mg.

Please speak with your healthcare professional regarding KEYTRUDA (pronounced key-true-duh). Only your healthcare professional knows the specifics of your condition and how KEYTRUDA may work with your overall treatment plan.
If you have any questions about KEYTRUDA, speak with your healthcare professional. **℞ONLY**

What is the most important information I should know about KEYTRUDA?
KEYTRUDA is a medicine that may treat certain cancers by working with your immune system. KEYTRUDA can cause your immune system to attack normal organs and tissues in any area of your body and can affect the way they work. These problems can sometimes become severe or life-threatening and can lead to death. These problems may happen anytime during treatment or even after your treatment has ended.

Call or see your doctor right away if you develop any symptoms of the following problems or these symptoms get worse:
Lung problems (pneumonitis). Symptoms of pneumonitis may include:
- shortness of breath
- chest pain
- new or worse cough

Intestinal problems (colitis) that can lead to tears or holes in your intestine. Signs and symptoms of colitis may include:
- diarrhea or more bowel movements than usual
- severe stomach-area (abdomen) pain or tenderness
- stools that are black, tarry, sticky, or have blood or mucus

Liver problems (hepatitis). Signs and symptoms of hepatitis may include:
- yellowing of your skin or the whites of your eyes
- dark urine
- nausea or vomiting
- feeling less hungry than usual
- pain on the right side of your stomach area (abdomen)
- bleeding or bruising more easily than normal

Hormone gland problems (especially the thyroid, pituitary, adrenal glands, and pancreas). Signs and symptoms that your hormone glands are not working properly may include:
- rapid heart beat
- weight loss or weight gain
- increased sweating
- feeling more hungry or thirsty
- urinating more often than usual
- hair loss
- feeling cold
- constipation
- your voice gets deeper
- muscle aches
- dizziness or fainting
- headaches that will not go away or unusual headache

Kidney problems, including nephritis and kidney failure. Signs of kidney problems may include:
- change in the amount or color of your urine

Skin problems. Signs of skin problems may include:
- rash
- itching
- blisters, peeling or skin sores
- painful sores or ulcers in your mouth or in your nose, throat, or genital area

Problems in other organs. Signs and symptoms of these problems may include:
- changes in eyesight
- severe or persistent muscle or joint pains
- severe muscle weakness
- low red blood cells (anemia)
- swollen lymph nodes, rash or tender lumps on skin, cough, shortness of breath, vision changes, or eye pain (sarcoidosis)
- confusion, fever, muscle weakness, balance problems, nausea, vomiting, stiff neck, memory problems, or seizures (encephalitis)
- shortness of breath, irregular heartbeat, feeling tired, or chest pain (myocarditis)

Infusion (IV) reactions that can sometimes be severe and life-threatening. Signs and symptoms of infusion reactions may include:
- chills or shaking
- shortness of breath or wheezing
- itching or rash
- flushing
- dizziness
- fever
- feeling like passing out

Rejection of a transplanted organ. People who have had an organ transplant may have an increased risk of organ transplant rejection. Your doctor should tell you what signs and symptoms you should report and monitor you, depending on the type of organ transplant that you have had.

Complications, including graft-versus-host-disease (GVHD), in people who have received a bone marrow (stem cell) transplant that uses donor stem cells (allogeneic). These complications can be severe and can lead to death. These complications may happen if you underwent transplantation either before or after being treated with KEYTRUDA. Your doctor will monitor you for the following signs and symptoms: skin rash, liver inflammation, stomach-area (abdominal) pain, and diarrhea.

Getting medical treatment right away may help keep these problems from becoming more serious. Your doctor will check you for these problems during treatment with KEYTRUDA. Your doctor may treat you with corticosteroid or hormone replacement medicines. Your doctor may also need to delay or completely stop treatment with KEYTRUDA, if you have severe side effects.

What should I tell my doctor before receiving KEYTRUDA?
Before you receive KEYTRUDA, tell your doctor if you:

- have immune system problems such as Crohn's disease, ulcerative colitis, or lupus
- have received an organ transplant, such as a kidney or liver
- have received or plan to receive a stem cell transplant that uses donor stem cells (allogeneic)
- have lung or breathing problems
- have liver problems
- have any other medical problems
- are pregnant or plan to become pregnant
  - KEYTRUDA can harm your unborn baby.

  Females who are able to become pregnant:
  - Your doctor will give you a pregnancy test before you start treatment with KEYTRUDA.
  - You should use an effective method of birth control during and for at least 4 months after the final dose of KEYTRUDA. Talk to your doctor about birth control methods that you can use during this time.
  - Tell your doctor right away if you think you may be pregnant or if you become pregnant during treatment with KEYTRUDA.
- are breastfeeding or plan to breastfeed.
  - It is not known if KEYTRUDA passes into your breast milk.
  - Do not breastfeed during treatment with KEYTRUDA and for 4 months after your final dose of KEYTRUDA.

Tell your doctor about all the medicines you take, including prescription and over-the-counter medicines, vitamins, and herbal supplements.

Know the medicines you take. Keep a list of them to show your doctor and pharmacist when you get a new medicine.

How will I receive KEYTRUDA?

- Your doctor will give you KEYTRUDA into your vein through an intravenous (IV) line over 30 minutes.
- KEYTRUDA is usually given every 3 weeks.
- Your doctor will decide how many treatments you need.
- Your doctor will do blood tests to check you for side effects.
- If you miss any appointments, call your doctor as soon as possible to reschedule your appointment.

What are the possible side effects of KEYTRUDA?
KEYTRUDA can cause serious side effects. See "What is the most important information I should know about KEYTRUDA?"
Common side effects of KEYTRUDA when used alone include: feeling tired, pain, including pain in muscles, bones or joints and stomach-area (abdominal) pain, decreased appetite, itching, diarrhea, nausea, rash, fever, cough, shortness of breath, and constipation.

Common side effects of KEYTRUDA when given with certain chemotherapy medicines include: feeling tired or weak, nausea, constipation, diarrhea, decreased appetite, rash, vomiting, cough, trouble breathing, fever, hair loss, and inflammation of the nerves that may cause pain, weakness, and paralysis in the arms and legs.

In children, feeling tired, vomiting and stomach-area (abdominal) pain, and increased levels of liver enzymes and decreased levels of salt (sodium) in the blood are more common than in adults.

These are not all the possible side effects of KEYTRUDA. For more information, ask your doctor or pharmacist.

Tell your doctor if you have any side effect that bothers you or that does not go away.

Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

General information about the safe and effective use of KEYTRUDA
Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide. If you would like more information about KEYTRUDA, talk with your doctor. You can ask your doctor or nurse for information about KEYTRUDA that is written for healthcare professionals.

In addition, you can go to www.keytruda.com.

Based on Medication Guide usmg-mk3475-iv-1902r021 as revised February 2019.

US-LAM-00131 03/19

MERCK

JUNE 2014 Fireworks commemorate the 70th anniversary of D-Day, when 156,000 Allied troops made a bloody landing on French shores to fight German forces.

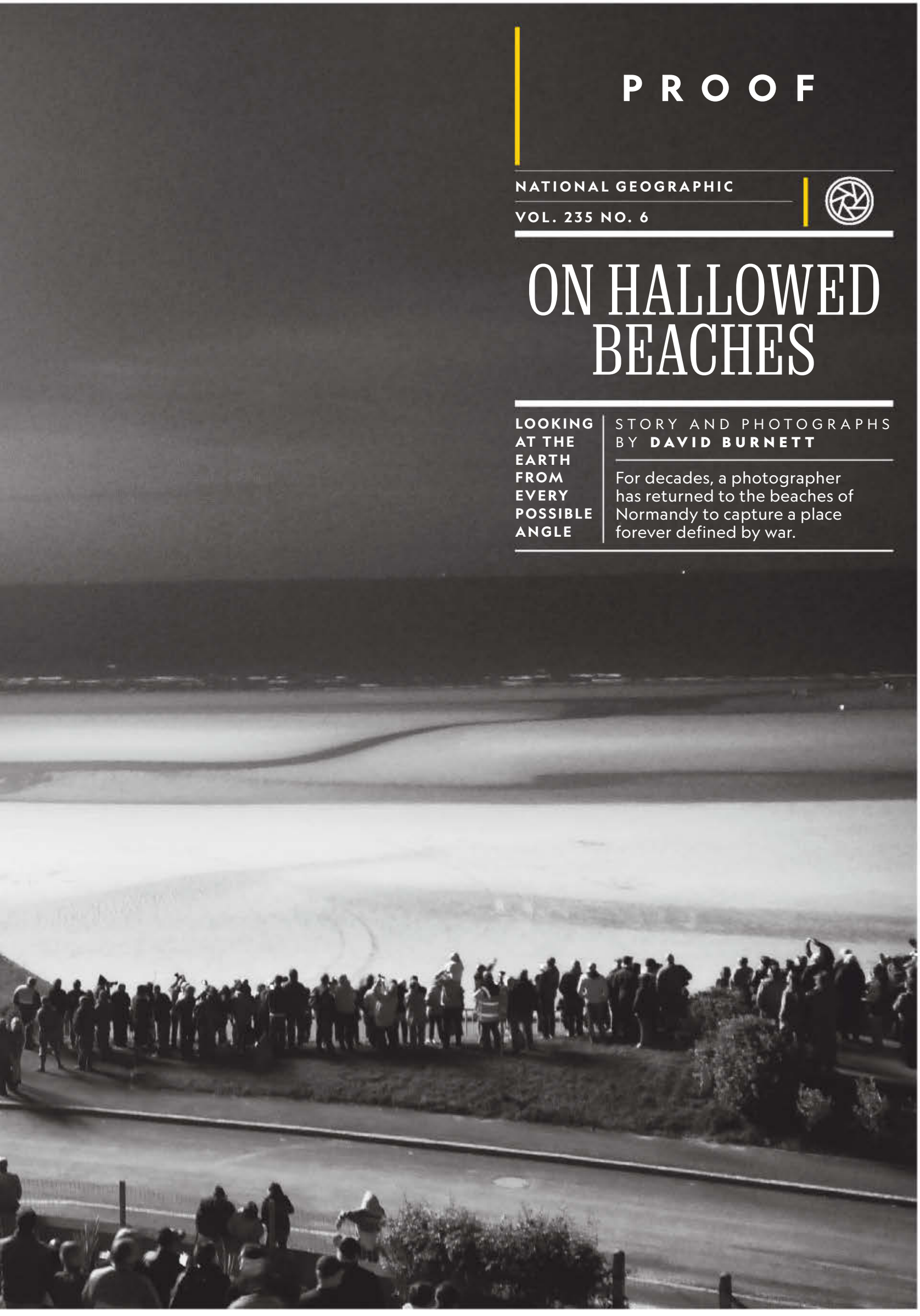
NATIONAL GEOGRAPHIC
VOL. 235 NO. 6

ON HALLOWED BEACHES

LOOKING AT THE EARTH FROM EVERY POSSIBLE ANGLE

STORY AND PHOTOGRAPHS BY **DAVID BURNETT**

For decades, a photographer has returned to the beaches of Normandy to capture a place forever defined by war.



JUNE 2014 An infrared image shows American graves in a cemetery at Colleville-sur-Mer, France (top).
JUNE 1974 U.S. Army Rangers reenact the invasion of Omaha Beach on the 30th anniversary of D-Day.

JUNE 1974 A French soldier returns to Pointe du Hoc, where Rangers scaled cliffs to capture German artillery (top). **MAY 1994** Remnants of German fortifications still stand on Cap Blanc-Nez.

JUNE 2014 Before dawn on D-Day, some 13,000 U.S. paratroopers dropped from planes above the French countryside. In this infrared image made 70 years later, the landing was reenacted near the town of Sainte-Mère-Église.

THE BACKSTORY

A PHOTOGRAPHER TRACES HIS 45-YEAR FASCINATION WITH THE BEACHES WHERE THE WORLD CHANGED.

I FIRST WENT TO NORMANDY in 1974. I was a 27-year-old news photographer shooting the French presidential election, and my visit happened to coincide with the 30th anniversary of the D-Day landings. I was amazed that the French still welcomed American veterans as their liberators—a warm feeling between the countries that still exists today.

Since that trip, I've returned to the beaches nearly a dozen times in the past half century, with each visit observing those hallowed sands and bearing witness to how the past refuses to be erased. I've met countless veterans who at first seem perfectly ordinary, like the guys I grew up with who ran the hardware store or pharmacy. I've had to pull their extraordinary stories out of them—each one a remarkable memory of a pivotal moment.

I see my responsibility as bridging the gap with photography to help people, particularly young people, understand the importance of what happened there—not just the soldiers who died, but also how the Allied invasion of German-occupied France changed the world. I've always been a fan of Edward R. Murrow, the American radio correspondent who delivered nightly radio reports from London during World War II. I like to play his reports on my cell phone when I'm walking on Omaha Beach and take in the accounts of what happened there in June 1944.

History has a way of receding. Our recollections become secondhand, then thirdhand, and eventually just words in a history book. But I'm not sure the same fate awaits Normandy. I've never met anybody, young or old, who walked on Omaha Beach and didn't feel the history of that place. There's something very powerful about putting your feet on the sand.

JUNE 1944 Robert Capa's well-known photograph shows Omaha Beach on D-Day. The invasion of Allied forces into German-controlled France shifted the balance of military power in World War II.

DAVID BURNETT PHOTOGRAPHS VIA CONTACT PRESS IMAGES

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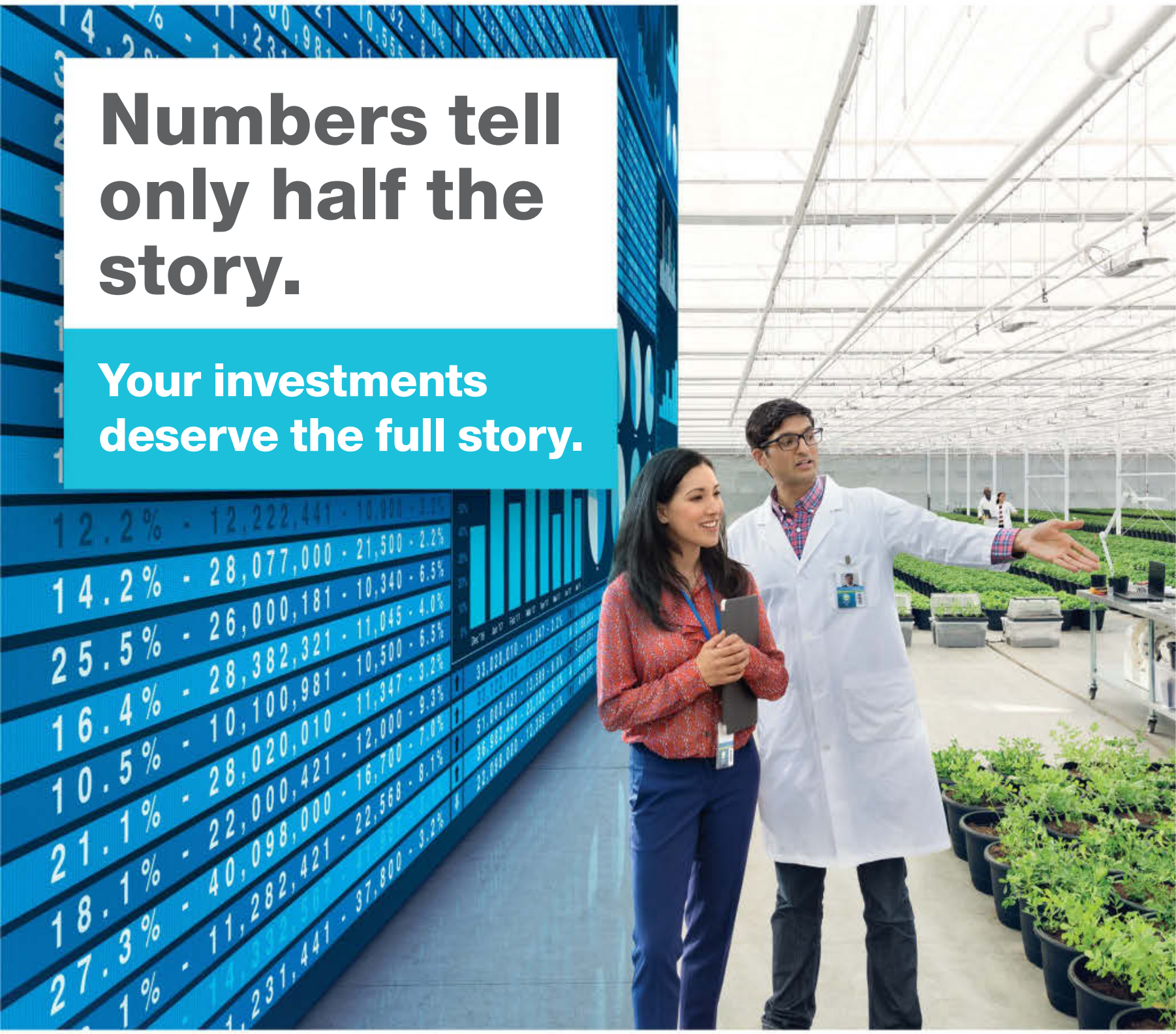

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THE DISCOVERIES OF TODAY THAT WILL DEFINE THE WORLD OF TOMORROW

NATIONAL GEOGRAPHIC | VOL. 235 NO. 6

In Search of the Kissing Bug

WHY IS SO LITTLE KNOWN ABOUT A PARASITIC INFECTION PLAGUING SOME 300,000 PEOPLE IN THE U.S.? BECAUSE IT'S A DISEASE OF POVERTY.

BY **DAISY HERNÁNDEZ**

I GREW UP BELIEVING that my auntie had almost died because she ate an apple in South America.

According to the family stories, the fruit had been contaminated, or maybe an insect had been crawling on it and had bitten Tía Dora. However it had happened, my family understood this: A New York doctor had diagnosed my auntie with Chagas disease. It meant my auntie could die. We didn't ask questions. English wasn't our first language. My parents worked in factories. We took care of my auntie as she went in and out of hospitals for decades. When I reached my late 30s, Tía Dora was rushed to the hospital one night. A week later, she died. She was 59 years old, and I thought Chagas was a rare disease. I was wrong.

Named after the Brazilian doctor who discovered the disease in 1909, Chagas is more prevalent today in the United States than the Zika virus. And in the Western Hemisphere, the disease burden of Chagas is almost eight times that of malaria.

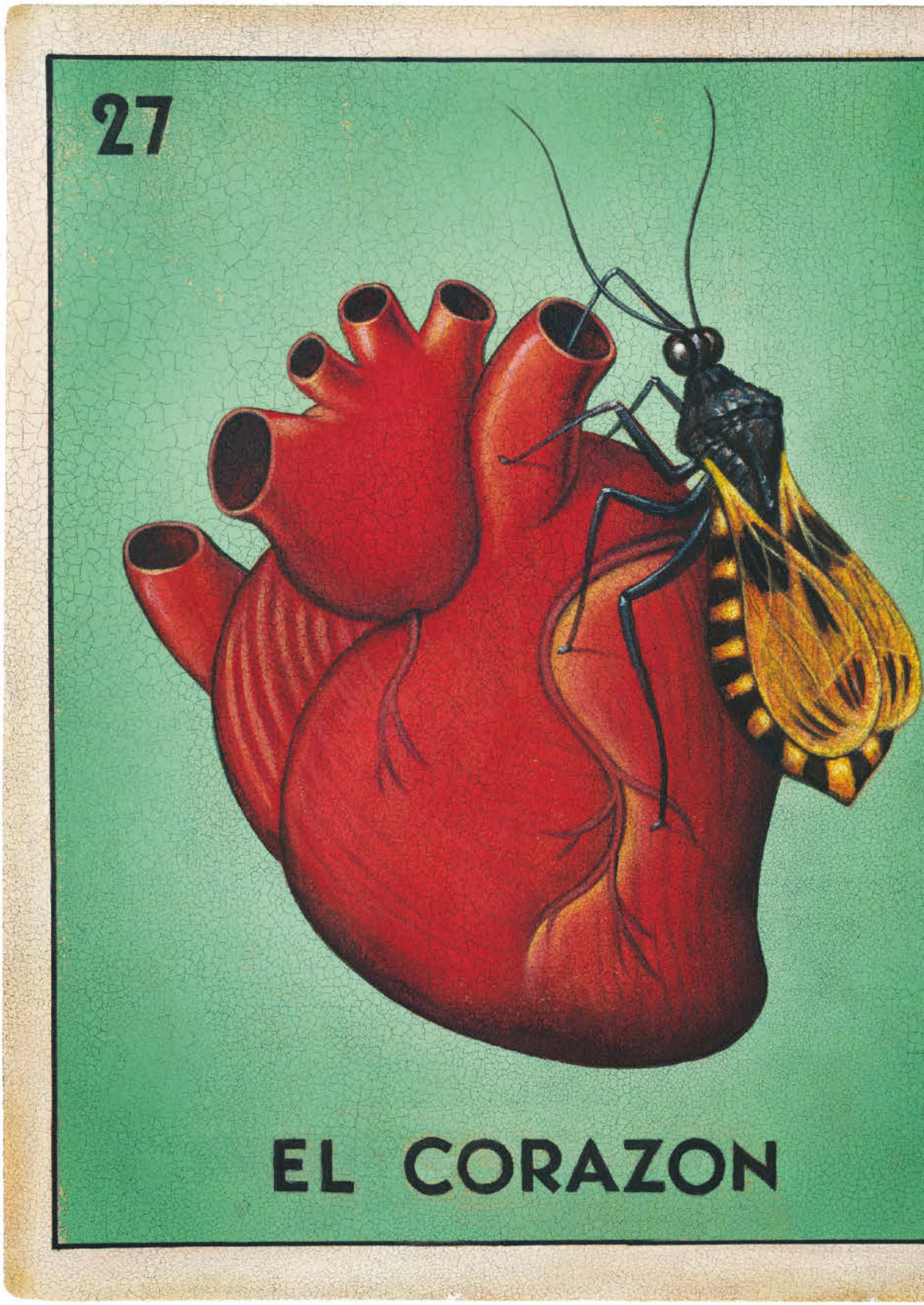

ILLUSTRATION: MARC BURCKHARDT

Another target of the bug's bite

In the United States, transmission of the deadly *Trypanosoma cruzi* parasite to humans is rare, but dogs appear to be more vulnerable. A recent study tested for Chagas disease among dogs that U.S. agencies use in tasks such as sniffing for explosives or helping with search-and-rescue operations. Though the dogs showed no signs of being sick, more than 7 percent of those tested were infected. "When we take a look at their hearts, then we see signs of heart disease," says study director Sarah Hamer, an associate professor at Texas A&M University's College of Veterinary Medicine and Biomedical Science. Similar rates of infection have been found among dogs in Texas animal shelters. Scientists say dogs might be more at risk for the disease than people because dogs may eat bugs that carry the parasite. However, they say, the risk of infection passing from dogs to humans is extremely low. –DH

THE PARASITE CAN LIVE IN THE BODY THROUGHOUT A PERSON'S LIFE WITHOUT CAUSING SYMPTOMS, BUT 20 TO 30 PERCENT OF INFECTED PEOPLE WILL SUFFER CARDIAC DAMAGE.

Some 10,000 people die each year from Chagas disease. The Centers for Disease Control and Prevention (CDC) estimates that about 300,000 people living in the United States have the disease. Many, like my auntie, grew up in poor communities in South America, Central America, or Mexico. Few know they have Chagas disease because the parasite that causes it, *Trypanosoma cruzi,* is a cunning microorganism.

It's transmitted to people by way of a triatomine insect called a kissing bug. In the acute stage, people usually can be cured; unfortunately, less than one percent of infected people are diagnosed or treated. The parasite can live in the body throughout a person's life without causing symptoms, but 20 to 30 percent of infected people will suffer cardiac damage. Chagas-related heart problems include irregular heartbeats, left ventricular aneurysms, and even heart failure.

Just as frightening is this: *T. cruzi* can cross the placenta. It's estimated that as many as 315 babies a year are born with Chagas in the United States. I think of them as the "no-name babies" because health officials don't know who these children are. Pregnant women are not routinely screened for Chagas in the United States.

In 2014, a few years after my auntie's death, I traveled to Colombia. At the University of the Andes in Bogotá, biologist Felipe Guhl has been studying the kissing bug disease for more than four decades. There I learned that these insects are homebodies, often living where they don't have to crawl far to reach prey. That might be a human, a dog, a marsupial, a raccoon—the bugs aren't picky about which animals they bite. In rural areas of Latin America, they live in the cracks of mud houses during the day and come out at night to feed. The bite, though painless, leaves a small wound. The *T. cruzi* parasite is in the bugs' feces and is transmitted when fecal material enters the bite wound.

Guhl says that to eradicate Chagas, you'd have to do away with wildlife—obviously not possible. Also, given the beetle-like bug's many species, "It's like a baseball game," he says. If you get rid of one, "there are other players on the bench." And the parasite itself is ancient. Guhl and an international team of researchers found *T. cruzi* in 9,000-year-old mummies from the deserts of Peru and Chile.

Having grown up hearing about Chagas disease and knowing that a dreaded bug could kill me, the last thing I wanted was to see one. And yet I did.

Maybe I wanted to face my fears. Maybe I wanted to see the truth of what I only knew as family folklore.

Off I went with Guhl's research assistant to see their insect colony. The day was chilly, but when the graduate student opened the door to a room the size of a walk-in closet, I stepped into a world both balmy and dimly lit. Think of a mild summer night out in the woods of North Carolina.

The room had shelves filled with glass jars of kissing bugs crawling on filter paper folded accordion style. Several were dark with pretty patterns of amber and black at the edges of their abdomens. Some, like the *Rhodnius prolixus,* were less than an inch long; others, like the *Panstrongylus geniculatus,* were longer. Kissing bugs tend to fly when they're starving. Now they began scrambling up the filter paper toward the cheesecloth covering on the jars. The graduate student smiled at me weakly. "They think we're going to feed them," he said. Their dinner? Chicken blood.

Kissing bugs are native to the United States, too. At Texas A&M in College Station, the entomology department has about a hundred specimens, collected years ago. In fact, Texas has the greatest diversity of kissing bug species in the country, and the CDC funded the start of the Texas Chagas Taskforce to raise awareness there.

The CDC, however, estimates 75 or fewer cases of what could be called "homegrown Chagas"—cases where people have been infected by kissing bugs native to the United States.

If we have kissing bugs aplenty in Texas and some 300,000 people in the U.S. infected, why do so few of us know about Chagas? "It's a disease of poverty," says Sheba Meymandi, a cardiologist whose team in California's San Fernando Valley has screened about 9,000 people who were born in Latin America for the disease. Many of the people infected have other issues to worry about: their immigration status, diabetes, and jobs that vanish overnight. Patients come to her when their hearts are failing. Because Chagas isn't easily transmitted between people, the disease stays largely confined to the Latino community—and that contributes to the lack of knowledge about it.

Through word of mouth in the Washington, D.C., area, I met Janet, a law school graduate from South America who's married to a U.S. citizen and who asked that we not use her last name to preserve her privacy. Janet had never been screened for Chagas, but her dad was infected and so was her sister. In 2015, pregnant with her second son, she found herself in an emergency room. Her baby, born at 30 weeks, was infected with *T. cruzi*. While babies infected with this parasite often don't show any signs of distress, Janet's premature son weighed less than four pounds and already had scar tissue on his heart. "It was shocking to learn that I could transmit this to my baby," she told me.

Doctors were able to treat Janet's son. But the recommended guidelines for newborn screening from the Department of Health and Human Services don't include congenital Chagas disease, even though there are more estimated cases of the disease than at least 15 other diseases currently listed.

This is particularly devastating because the drug benznidazole can often eliminate the parasite in infected children. In 2017 the Food and Drug Administration approved the drug for use among children. It sounds like good news, and it is, except benznidazole, which was developed in the 1960s and '70s, can have negative side effects for people with chronic Chagas. The other drug available for Chagas, nifurtimox, also has these limitations. Research funds continue to be scarce for this disease.

I've come a long way from thinking that my auntie ate a poisoned apple and contracted an infectious disease. However, the real story—spanning borders and sitting at the intersection of science and social issues like poverty and immigration—has also become more complicated than anything I could have imagined when I was a child. ▯

Daisy Hernández is the author of *A Cup of Water Under My Bed: A Memoir* and co-editor of *Colonize This! Young Women of Color on Today's Feminism*. She is an assistant professor in the creative writing program at Miami University in Ohio, and her book, *In Search of the Kissing Bug,* is forthcoming from Tin House Books.

DARWIN, CHAGAS VICTIM?

The diagnosis has been debated, but some doctors have hypothesized that Charles Darwin was infected with *T. cruzi* during his voyages on the H.M.S. *Beagle*. Darwin's journal suggests that he suffered kissing bug bites, and later in life he developed some Chagas-like symptoms.

Disease Cases Down

The World Health Organization lists Chagas, sleeping sickness, and Guinea worm disease among "neglected tropical diseases." But there's progress reining them in thanks to successful interventions: controlling for disease vectors, ensuring that people can filter their water, and getting infected people access to health care.

Sleeping sickness
Parasites enter the body through tsetse fly (left) bites.
1999: 27,862 chronic cases
2017: 1,420 chronic cases

Guinea worm disease
Guinea worm larvae enter the body via drinking water.
1989: 892,055 infected
2018: 28 infected

Chagas disease
1990: 30 million infected
2010: 6 to 8 million infected

PHOTO: GEOFFREY M. ATTARDO

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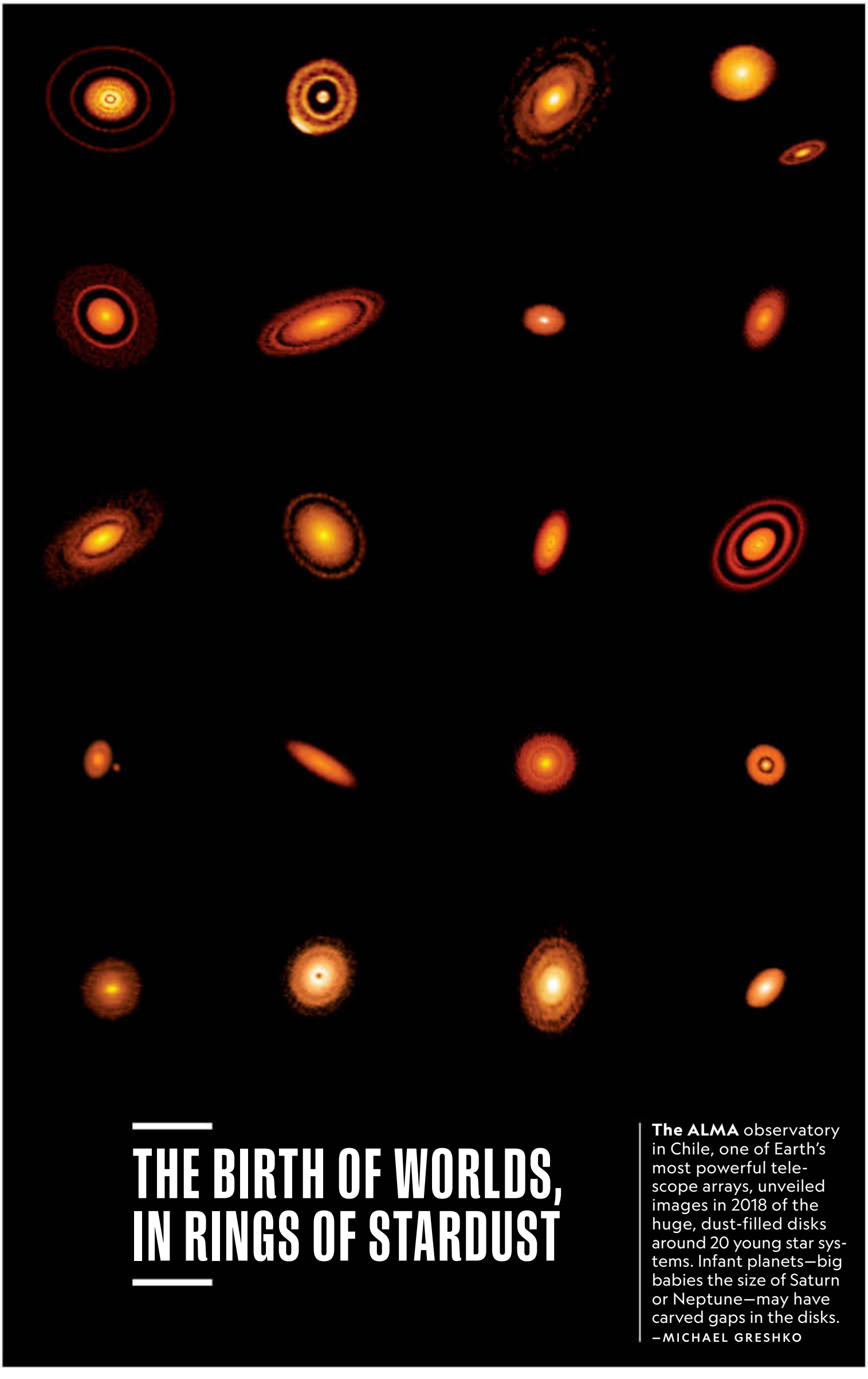
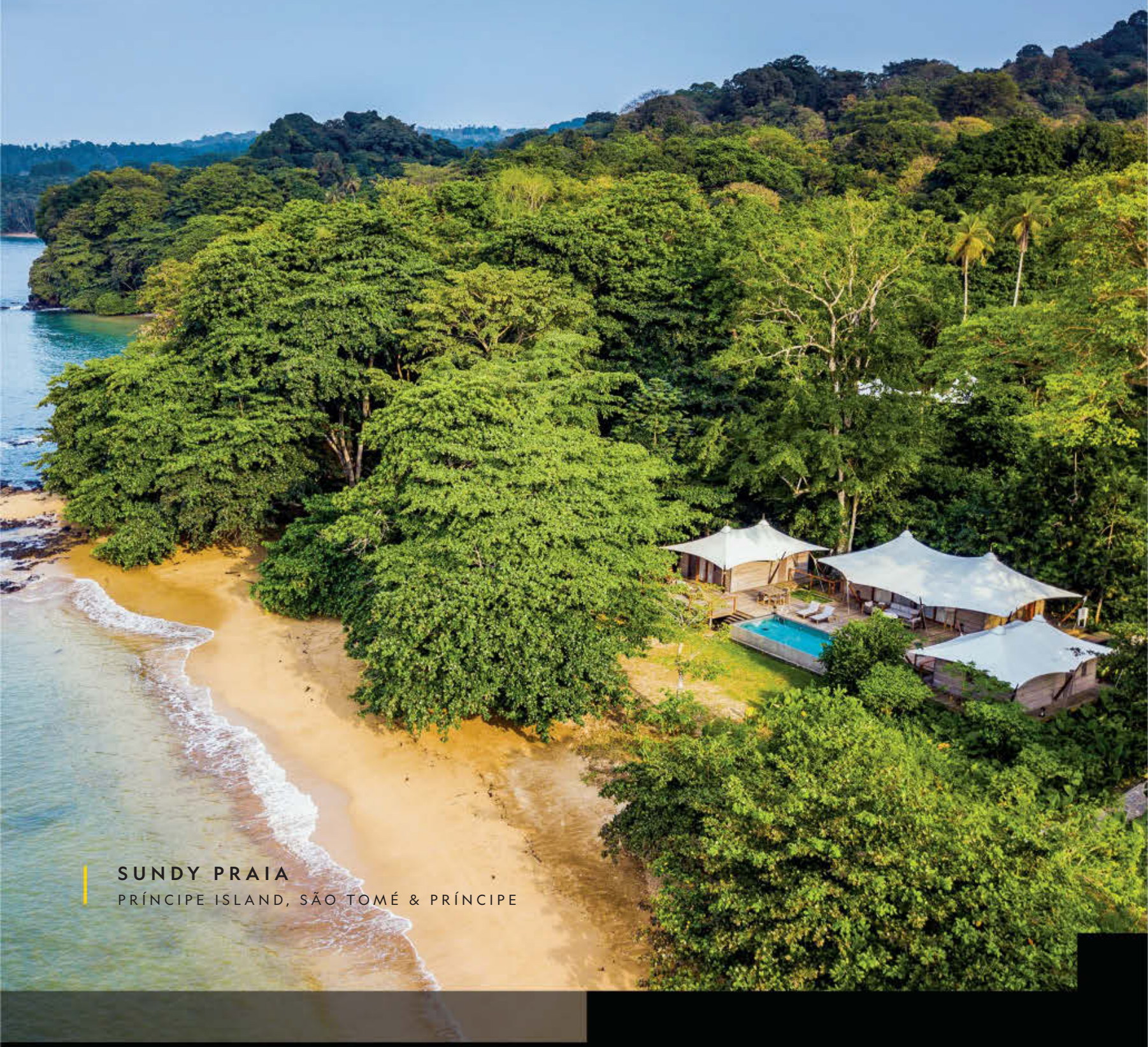


THE BIRTH OF WORLDS, IN RINGS OF STARDUST

The ALMA observatory in Chile, one of Earth's most powerful telescope arrays, unveiled images in 2018 of the huge, dust-filled disks around 20 young star systems. Infant planets—big babies the size of Saturn or Neptune—may have carved gaps in the disks.
–MICHAEL GRESHKO

PHOTO: S. ANDREWS AND OTHERS, ALMA (ESO/NAOJ/NRAO); S. DAGNELLO, NRAO/AUI/NSF

STAY UNIQUE



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DISPATCHES FROM THE FRONT LINES OF SCIENCE AND INNOVATION

This is a whale's earwax.
Museums have long collected whale specimens, many containing massive plugs of earwax. Scientists have recently found that whales add two layers to a plug each year and that layers containing high cortisol levels correlate to times when whales face extra stress: during World War II, peak whale hunting, and the rise of ocean temperatures. —CHRISTIE WILCOX

Shown actual size, roughly 10 inches in length

ROBOTS

POPPING POTENTIAL

ENGINEERS HARNESS THE POWER OF POPCORN (HOLD THE BUTTER)

LOW-TECH, LOW-COST ROBOTS could run on an unlikely material, say researchers at Cornell University: popcorn. When heat is applied, kernels undergo an "amazing transition," expanding in less than a second, says engineer Kirstin Petersen. This makes popcorn a good candidate for powering a variety of robots, including those that must transform from flexible to rigid to perform a task. Imagine, for instance, a kernel-filled, silicone robot that can squeeze into a crack in a dam and then plug it by "popping." Trials continue, but some popcorn robots already have a clear benefit: They'd be biodegradable.
—CATHERINE ZUCKERMAN

ANIMALS

Flying Squirrels Also Glow

In case the ability to glide between trees isn't cool enough, under ultraviolet light, flying squirrels' fur glows pink (below). They are one of the few mammals known to fluoresce: absorb light in one color, or wavelength, and emit it in another. The glow may aid nighttime perceptions and communication, especially in winter, suggests mammalogist Paula Spaeth Anich. "The trait might be more visible, or noticeable, in snowy conditions because of the high rate of UV reflectance off of snow."
—JAKE BUEHLER

PHOTOS (CLOCKWISE FROM LEFT): BRUCE AND GREG DALE, NATIONAL GEOGRAPHIC CREATIVE; STEPHEN J. TRUMBLE, BAYLOR UNIVERSITY; JONATHAN G. MARTIN, NORTHLAND COLLEGE, IN ALLISON M. KOHLER AND OTHERS, *JOURNAL OF MAMMALOGY,* 2019

WORLD BEAT

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IMFINZI SIGNIFICANTLY REDUCED THE CHANCE OF LUNG CANCER SPREADING

IMFINZI may not work for everyone.

IMFINZI was studied in 713 patients with unresectable Stage 3 NSCLC who completed at least 2 cycles of chemotherapy that contained platinum given at the same time (concurrent) as radiation before starting the trial. Patients in the study had good performance status (WHO 0 or 1). IMFINZI was tested against placebo (no medication).

The main goal of the trial was to measure the length of time people remained progression free (without cancer growing or spreading) and overall survival. At the time of analysis, overall survival comparison was not yet available. This trial is still ongoing.

WHO IS IMFINZI FOR?

IMFINZI® (durvalumab) is a prescription medicine used to treat a type of lung cancer called non-small cell lung cancer (NSCLC). IMFINZI may be used when your NSCLC has not spread outside your chest, cannot be removed by surgery, **and** has responded or stabilized with initial treatment with chemotherapy that contains platinum, given at the same time as radiation therapy.

It is not known if IMFINZI is safe and effective in children.

IMPORTANT SAFETY INFORMATION

What is the most important information I should know about IMFINZI?

IMFINZI is a medicine that may treat a type of lung cancer by working with your immune system.

IMFINZI can cause your immune system to attack normal organs and tissues and can affect the way they work. These problems can sometimes become serious or life-threatening and can lead to death.

Call or see your healthcare provider right away if you develop any symptoms of the following problems or if these symptoms get worse:

Lung problems (pneumonitis). Signs and symptoms may include new or worsening cough, shortness of breath, and chest pain.

Liver problems (hepatitis). Signs and symptoms may include yellowing of your skin or the whites of your eyes, severe nausea or vomiting, pain on the right side of your stomach area (abdomen), drowsiness, dark urine (tea colored), bleeding or bruising more easily than normal, and feeling less hungry than usual.

Intestinal problems (colitis). Signs and symptoms may include diarrhea or more bowel movements than usual; stools that are black, tarry, sticky, or have blood or mucus; and severe stomach-area (abdomen) pain or tenderness.

Hormone gland problems (especially the thyroid, adrenals, pituitary, and pancreas). Signs and symptoms that your hormone glands are not working properly may include headaches that will not go away or unusual headaches; extreme tiredness; weight gain or weight loss; dizziness or fainting; feeling more hungry or thirsty than usual; hair loss; feeling cold; constipation; your voice gets deeper; urinating more often than usual; nausea or vomiting; stomach-area (abdomen) pain; and changes in mood or behavior, such as decreased sex drive, irritability, or forgetfulness.

Kidney problems, including nephritis and kidney failure. Signs of kidney problems may include decrease in the amount of urine, blood in your urine, swelling of your ankles, and loss of appetite.

Skin problems. Signs may include rash, itching, and skin blistering.

Problems in other organs. Signs and symptoms may include neck stiffness; headache; confusion; fever; chest pain, shortness of breath, or irregular heartbeat (myocarditis); changes in mood or behavior; low red blood cells (anemia); excessive bleeding or bruising; muscle weakness or muscle pain; blurry vision, double vision, or other vision problems; and eye pain or redness.

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IMFINZI is an immunotherapy. People receiving IMFINZI had a 48% lower chance of lung cancer growing or spreading than those receiving placebo (no medicine). It was also proven to give people 3x more time without their cancer spreading compared with placebo.* Before IMFINZI, the last 10 years showed only limited advancements to the current standard of care for unresectable Stage 3 NSCLC.

*In a clinical trial, the median time tumors did not grow or spread was 16.8 months for the 476 patients receiving IMFINZI compared with 5.6 months for the 237 patients receiving placebo. Median is the middle number in a group of numbers arranged from lowest to highest. Individual results may vary.

ASK YOUR DOCTOR ABOUT IMFINZI. VISIT IMFINZI.COM

Severe infections. Signs and symptoms may include fever, cough, frequent urination, pain when urinating, and flu-like symptoms.

Severe infusion reactions. Signs and symptoms may include chills or shaking, itching or rash, flushing, shortness of breath or wheezing, dizziness, fever, feeling like passing out, back or neck pain, and facial swelling.

Getting medical treatment right away may help keep these problems from becoming more serious. Your healthcare provider will check you for these problems during your treatment with IMFINZI. Your healthcare provider may treat you with corticosteroid or hormone replacement medicines. Your healthcare provider may delay or completely stop treatment with IMFINZI if you have severe side effects.

Before you receive IMFINZI, tell your healthcare provider about all of your medical conditions, including if you have immune system problems such as Crohn's disease, ulcerative colitis, or lupus; have had an organ transplant; have lung or breathing problems; have liver problems; or are being treated for an infection.

If you are pregnant or plan to become pregnant, tell your healthcare provider. IMFINZI can harm your unborn baby. If you are able to become pregnant, you should use an effective method of birth control during your treatment and for at least 3 months after the last dose of IMFINZI. Talk to your healthcare provider about which birth control methods to use. Tell your healthcare provider right away if you become pregnant during treatment with IMFINZI.

If you are breastfeeding or plan to breastfeed, tell your healthcare provider. It is not known if IMFINZI passes into breast milk. Do not breastfeed during treatment with IMFINZI and for at least 3 months after the last dose of IMFINZI.

Tell your healthcare provider about all the medicines you take. This includes prescription and over-the-counter medicines, vitamins, and herbal supplements.

What are the possible side effects of IMFINZI?

IMFINZI can cause serious side effects (see earlier).

The most common side effects in people with non-small cell lung cancer (NSCLC) include cough, feeling tired, inflammation in the lungs (pneumonitis), upper respiratory tract infections, shortness of breath, and rash.

Tell your healthcare provider if you have any side effect that bothers you or that does not go away. These are not all the possible side effects of IMFINZI. Ask your healthcare provider or pharmacist for more information.

Call your healthcare provider for medical advice about side effects.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.FDA.gov/medwatch or call 1-800-FDA-1088.

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IMFINZI™ durvalumab Injection for Intravenous Use 50 mg/mL

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- drowsiness
- dark urine (tea colored)
- bleeding or bruising more easily than normal
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- feeling more hungry or thirsty than usual
- hair loss
- changes in mood or behavior, such as decreased sex drive, irritability, or forgetfulness
- feeling cold
- constipation
- your voice gets deeper
- urinating more often than usual
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- decrease in the amount of urine
- blood in your urine
- swelling of your ankles
- loss of appetite

Skin problems. Signs of these problems may include:

- rash
- itching
- skin blistering

(continued)

Problems in other organs. Signs and symptoms may include:

- neck stiffness
- headache
- confusion
- fever
- chest pain, shortness of breath, or irregular heartbeat (myocarditis)
- changes in mood or behavior
- low red blood cells (anemia)
- excessive bleeding or bruising
- muscle weakness or muscle pain
- blurry vision, double vision, or other vision problems
- eye pain or redness

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- flu-like symptoms

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- dizziness
- fever
- feel like passing out
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- facial swelling

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- have liver problems
- are being treated for an infection
- are pregnant or plan to become pregnant. IMFINZI can harm your unborn baby. If you are able to become pregnant, you should use an effective method of birth control during your treatment and for at least 3 months after the last dose of IMFINZI. Talk to your healthcare provider about birth control methods that you can use during this time. Tell your healthcare provider right away if you become pregnant during treatment with IMFINZI.
- are breastfeeding or plan to breastfeed. It is not known if IMFINZI passes into your breast milk. Do not breastfeed during treatment and for at least 3 months after the last dose of IMFINZI.

(continued)

Tell your healthcare provider about all the medicines you take, including prescription and over-the-counter medicines, vitamins, and herbal supplements.

HOW WILL I RECEIVE IMFINZI?

- Your healthcare provider will give you IMFINZI into your vein through an intravenous (IV) line over 60 minutes.
- IMFINZI is usually given every 2 weeks.
- Your healthcare provider will decide how many treatments you need.
- Your healthcare provider will test your blood to check you for certain side effects.
- If you miss any appointments, call your healthcare provider as soon as possible to reschedule your appointment.

WHAT ARE THE POSSIBLE SIDE EFFECTS OF IMFINZI?

IMFINZI CAN CAUSE SERIOUS SIDE EFFECTS, INCLUDING:

SEE "WHAT IS THE MOST IMPORTANT INFORMATION I SHOULD KNOW ABOUT IMFINZI?"

The most common side effects of IMFINZI in people with NSCLC include:

- cough
- feeling tired
- inflammation in the lungs (pneumonitis)
- upper respiratory tract infections
- shortness of breath
- rash

Tell your healthcare provider if you have any side effect that bothers you or that does not go away.

These are not all the possible side effects of IMFINZI. Ask your healthcare provider or pharmacist for more information. Call your healthcare provider for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

GENERAL INFORMATION ABOUT THE SAFE AND EFFECTIVE USE OF IMFINZI.

Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide. If you would like more information about IMFINZI, talk with your healthcare provider. You can ask your healthcare provider for information about IMFINZI that is written for health professionals.

AstraZeneca

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This Patient Information has been approved by the U.S. Food and Drug Administration. Issued: 02/2018

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PHOTOGRAPH COURTESY OF MICHAEL NICHOLS | **19PGAD06**

NATIONAL GEOGRAPHIC

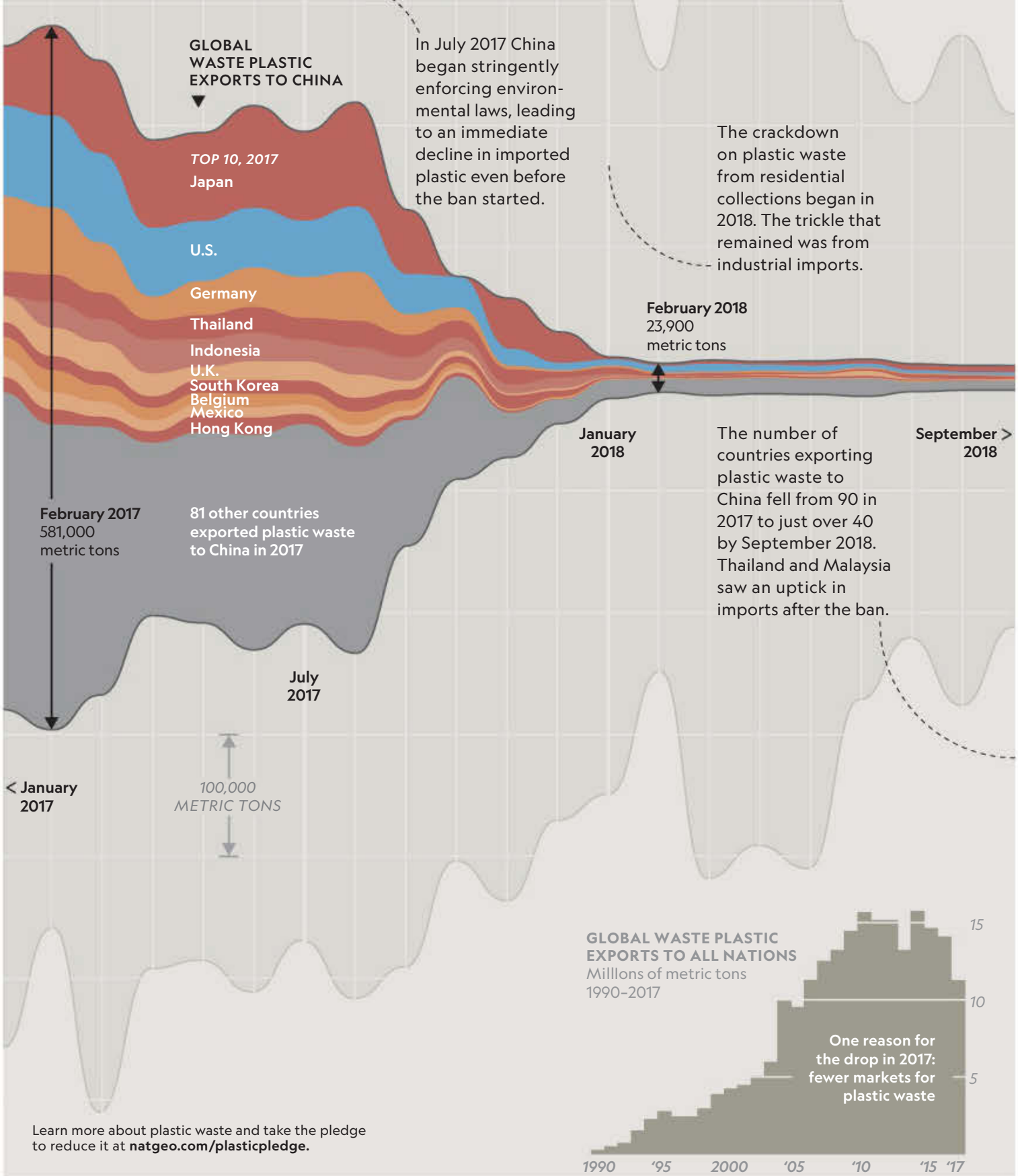
PLASTIC WASTE CRACKDOWN

AFTER IMPORTING NEARLY half of the planet's plastic recyclables for three decades, China barred the import of most residential recyclables in 2017. The ban is part of its efforts to clean its environment and improve quality of life. Now other countries in Asia are increasing their plastic waste imports, raising environmental concerns about their ability to handle such large volumes of recyclables. Meanwhile, in developed countries many domestic recycling programs have been halted because of the cost.

BY **SEAN McNAUGHTON** AND **KELSEY NOWAKOWSKI**

GLOBAL WASTE PLASTIC EXPORTS TO ALL NATIONS

January 2017—September 2018*



Learn more about plastic waste and take the pledge to reduce it at **natgeo.com/plasticpledge.**

*LATEST AVAILABLE DATA. INDONESIA'S 2018 EXPORT DATA WERE NOT AVAILABLE.

SOURCES: UN COMTRADE; THAI CUSTOMS DEPARTMENT; HONG KONG CENSUS AND STATISTICS DEPARTMENT; KOREA CUSTOMS SERVICE; EUROSTAT; ADINA R. ADLER, INSTITUTE OF SCRAP RECYCLING INDUSTRIES; AMY BROOKS, JENNA JAMBECK, SHUNLI WANG, UNIVERSITY OF GEORGIA

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GENIUS

MA JUN

BY **RACHEL HARTIGAN SHEA** PHOTOGRAPH BY **REBECCA HALE**

He Gives People the Power to Fight Pollution

More than a million people in China died from the effects of ambient air pollution in 2016, according to the World Health Organization. It's a shocking number, and Ma Jun is exerting steady pressure on the Chinese government and private companies to reduce it.

A former investigative reporter who wrote a groundbreaking book called *China's Water Crisis,* Ma founded the Institute of Public and Environmental Affairs (IPE) in 2006. The organization aims to make environmental data accessible. "We have to involve the people in our environmental governance," says Ma. "They must be informed."

At first there was little data to share. But in 2013 China vowed to "declare war" on pollution and began releasing the hourly levels of $PM_{2.5}$, the especially harmful fine-particle pollutants. IPE and its partners pushed for the sources of those pollutants to be disclosed. When that happened a year later, IPE incorporated this new data into an online map and phone app called the Blue Map, where users can check the air quality of more than 300 Chinese cities and the water quality of thousands of rivers.

Now Chinese citizens can see whether it's safe to send their children outside to play—and if it isn't, they can identify which factories are to blame. Companies are facing public pressure to clean up, says Ma. Just as important, he says, the government has been convinced "that environmental transparency will not disrupt our society." ▯

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IN THIS SECTION
Dragonflies Fake Death
Making Movie Sounds
Historic Nightlife
Tortoise Domination

ILLUMINATING THE MYSTERIES—AND WONDERS—ALL AROUND US EVERY DAY
NATIONAL GEOGRAPHIC | VOL. 235 NO. 6

TREK TO THE DEEP

In Vietnam, jungle and leeches greet hikers on their way to explore two of the world's largest caves.

ITALIAN PHYSICIST and photographer Alessandro Cerè took a break from work at the Centre for Quantum Technologies in Singapore to venture into Hang En (pictured) and Hang Son Doong, two of the top three largest known caves in the world. To get there, a punishing path and 90 percent humidity test even the fittest hiker.

T MINUS ONE MONTH

A WALK FOR THE FORTUNATE FEW

Only a limited number of travelers are allowed to visit these caves each year, but Cerè snagged a last-minute spot through a friend of a friend. Looking at photos online, he knew he'd need a lens that could handle the light contrasts inside the caves and decided to invest in new camera equipment. As the trip approached, Cerè ran every day to prepare for the physical toll of hiking and climbing in the sweltering jungle.

T MINUS ONE WEEK

ESSENTIAL PACKING LIST

The trip poses at least one confounding packing problem: It's wet and muddy, but nonbreathable waterproof boots can breed foot infections.

- Permeable hiking shoes that dry quickly
- Foot powder to prevent bacterial infection
- A waterproof bag to store essentials during river crossings
- Long pants and long-sleeve shirts to protect from leeches
- Tablets to replace electrolytes lost in sweat
- A tripod to stabilize the camera in low light

T MINUS ZERO DAYS

READY FOR LAUNCH

The expedition members met in Hanoi for a few days to get to know each other and then took a quick flight to Dong Hoi. Entering the jungle, Cerè switched his phone off, glad to be unreachable. The narrow paths flowed up and down. The group spent four days wading through hip-high waters before traversing through and camping in soaring caves. At the end of Hang Son Doong stood the Great Wall of Vietnam, a 200-foot barrier to be conquered by both ladder and rope climbing.

‘IN A CAVE THERE’S NO WAY TO GET A SIGNAL. THERE’S NO WAY TO TALK WITH ANYBODY EXCEPT THE PEOPLE AROUND YOU.’

—Alessandro Cerè

BY THE NUMBERS

28

MILES HIKED OVER FOUR DAYS

459

FEET HIGH INSIDE HANG EN

55

POUNDS OF PHOTO GEAR IN PACK

BY **NINA STROCHLIC** PHOTOGRAPH BY **ALESSANDRO CERÈ**

FAKING TO AVOID SEX? SHE'S DEAD SERIOUS ABOUT IT

THE MATING RITUAL of the moorland hawker dragonfly—common around the ponds and wetlands of Europe, Asia, and North America—begins with what biologist Rassim Khelifa calls "an acrobatic aerial copulation." While in flight, the female *Aeshna juncea* contorts so that her genitals, which are near the end of her body, connect with the male's genitals, which are near his thorax. Thus joined in a lopsided-heart shape (right), they land and complete the sex act, whereupon the female will head off to lay her eggs.

Before she can do that, other males may show up seeking sex. Evolution predisposes her to resist: She has limited eggs, her reproductive tract can be damaged by repeated copulations, she's already been inseminated by the mate she chose, and the dragonfly penis is structured so that it removes any sperm present before making a new deposit. So to avoid further sex, she may fall down dead—or more precisely, she may fake death, dropping from the air and lying motionless in the ground cover.

At the University of Zurich, Khelifa conducted a study of the females' death feigning and found that usually "their strategy works." Most males buzzed the crash site briefly, he says, then flew off to look for other conquests. Once the males left, the lifeless-looking females stirred and went on their way.

—PATRICIA EDMONDS

Acting Dead Can Be Animals' Advantage

Assuming a lifeless-looking, immobile state in an effort to discourage or ambush a predator is known as tonic immobility, death feigning, or thanatosis. It's been seen in a wide variety of vertebrates and invertebrates.

HOGNOSE SNAKE

To make their fake death throes as convincing as possible, hognose snakes of the North American genus *Heterodon* have been known to secrete a foul-smelling fluid and even spew blood.

VIRGINIA OPOSSUM

When threatened, an opossum will faint and look quite dead—from its prone posture to its drooling, tongue-lolling grimace—which led to the phrase "playing possum" to refer to feigning death.

PREDATORY CICHLID

At least two species of this fish may lure prey by sinking to the bottom of a river or lake and lying still as a corpse. If small fish approach to scavenge, the cichlid lunges and makes a meal of them. –PE

PHOTO: RASSIM KHELIFA

IF YOU ARE OR WERE A HOLDER OF OR OTHERWISE CLAIM ENTITLEMENT TO A PAYMENT IN CONNECTION WITH CERTAIN SECURITIES FOR WHICH JPMORGAN CHASE BANK, N.A. ("JPM") SERVED AS DEPOSITARY, YOUR RIGHTS MAY BE AFFECTED.

Pursuant to Federal Rule of Civil Procedure 23 and Court Order, *Merryman, et al. v. JPMorgan Chase Bank, N.A.*, No. 1:15-cv-09188-VEC (S.D.N.Y.) has been provisionally certified as a class action for settlement purposes and a $9,500,000 settlement has been proposed, which, if approved, will resolve all claims in the litigation. **This notice provides basic information. It is important that you review the detailed notice ("Notice") found at the website below.**

What is this lawsuit about:

Plaintiffs claim that JPM, as depositary bank for the American Depositary Receipts or securities covered by the litigation ("ADRs"), assigned foreign exchange rates ("FX") to the conversion of non-U.S. dollar-based cash distributions, which reflected a spread that was added to the FX rate JPM actually received at the time of the conversion, and thereby improperly retained class member dollars from such distributions. JPM has denied, and continues to deny, any wrongdoing or liability whatsoever.

Who is a Settlement Class Member:

Persons or entities who are or were holders (directly or indirectly, registered or beneficially) of or otherwise claim any entitlement to any payment (dividend, rights offering, interest on capital, sale of shares or other distribution) in connection with (i) securities listed on Appendix 1 to the Notice (including any predecessor or successor) from November 21, 2010 to July 18, 2018; or (ii) securities listed on Appendix 2 to the Notice (including any predecessor or successor) from November 21, 2012 to July 18, 2018.

What are the benefits:

If the Court approves the settlement, the proceeds, after deduction of Court-approved notice and administration costs, attorneys' fees and expenses, will be distributed pursuant to the Plan of Allocation in the Notice, or other plan approved by the Court.

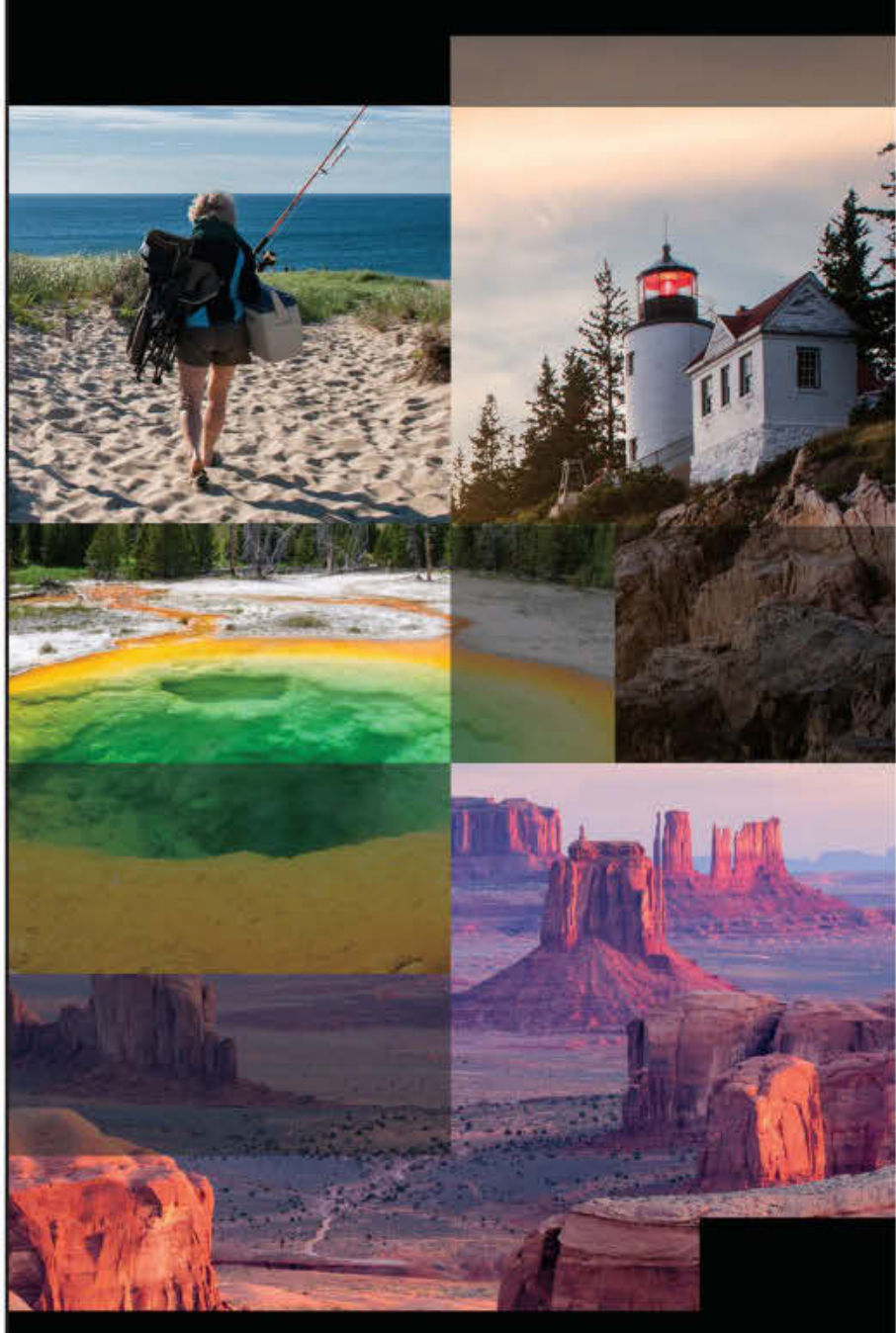
What are my rights:

If you hold (or held) your ADRs directly and are listed on JPM's transfer agent records, you are a Registered Holder Settlement Class Member and *do not* have to take any action to be eligible for a settlement payment. However, if you hold (or held) your ADRs through a bank, broker or nominee and are not listed on JPM's transfer agent records, you are a Non-Registered Holder Settlement Class Member and you *must submit* a Claim Form, ***postmarked by September 19, 2019***, to be eligible for a settlement payment. Non-Registered Holder Settlement Class Members who do nothing will not receive a payment, and will be bound by all Court decisions.

If you are a Settlement Class Member and do not want to remain in the Settlement Class, you may exclude yourself by request, ***received by July 3, 2019***, in accordance with the Notice. If you exclude yourself, you will *not* be bound by any Court decisions in this litigation and you will *not receive a payment*, but you will retain any right you may have to pursue your own litigation at your own expense concerning the settled claims. Objections to the settlement, Plan of Allocation, or request for attorneys' fees and expenses must be ***received by July 3, 2019***, in accordance with the Notice.

A hearing will be held on **August 8, 2019 at 11:00 a.m.**, before the Honorable Valerie E. Caproni, at the Thurgood Marshall U.S. Courthouse, 40 Foley Square, NY, NY 10007, to determine if the settlement, Plan of Allocation, and/or request for fees and expenses should be approved. Supporting papers will be posted on the website once filed.

For more information visit
www.JPMorganADRFXSettlement.com
email info@JPMorganADRFXSettlement.com
or call 1.866.637.9457



1. Pine cone
Full of crunch, pine cones excel at re-creating the sound of breaking bones. Roesch and his team also used pine cones to mimic hedgehogs rolling down a hill in the children's movie *Ferdinand* by scraping the cones with a hairbrush.

2. Cat-o'-nine-tails
This whip was perfect for making the sound of an alien's tentacles slapping against a window in *Independence Day.*

3. Spurs
To add a "real Western feel" to the 1985 film *Silverado,* the Foley artists relied on spurs.

4. Audiotape
For simulating the sound of feet walking on grass, the team likes this prop because it adds "crispness."

5. Baby sneakers
Small and rubbery, these little shoes helped bring the Minions' footsteps to life in the animated hit *Despicable Me 3.*

SOUND SYSTEM

WHAT WOULD A SCARY movie be without the ominous creak of floorboards? Sound effects—called Foley—add crucial value to any film. "The challenge," says Foley artist John Roesch, "is to create something in sync with the picture that is totally believable." Step one: watching a scene in silence. "I hear the sound in my mind," says Roesch. Then with his partners, Shelley Roden and Scott Curtis, he tinkers with countless gadgets and props at the Skywalker Sound studio in Marin County, California, to try to replicate it. To "Foley" an ice-skating scene, for example, he drags crampons across concrete. And if the plot should take a perilous turn? Squeezing a water-soaked chamois cloth, says Roesch, makes the perfect "blood gooshy" sound.

—CATHERINE ZUCKERMAN

PHOTOGRAPH BY **ANNIE MARTIN**

6. Bone fragment
The Foley team used bits of bone to replicate the sound of Maui's bone necklace in the popular kids movie *Moana*.

7. Broadsword
The sound made by wielding this hefty weapon emphasized the power of the swords in *Braveheart*.

8. Candleholder
In *Black Panther,* the 2018 superhero blockbuster, the title character wears a suit made of a fictional metal called vibranium. To make its sound, Roesch employed several implements, including this metal candleholder and an S-shaped crowbar.

9. Boing box
This custom-built, single-string instrument supplied cartoon sounds for the 1988 comedy *Who Framed Roger Rabbit?* On its surface are five unrelated sound props (clockwise from top right: Jew's harp, tuning fork, lighter, brass cup, brass top).

HEAR THESE TOOLS IN ACTION AT *NGM.COM/JUN2019.*

PREJUDICE AND PRIDE IN NEW YORK CITY

STONEWALL INN, 1969–When lesbian, gay, bisexual, transgender, and queer (LGBTQ) people resisted a police raid at this Greenwich Village tavern, they brought a growing liberation movement to light. Today, LGBTQ cultural life in New York City is more visible than ever, and researchers are reconstructing its hidden history. To create a map of nightlife, Jeff Ferzoco of the project OUTgoing NYC scoured libraries and collected personal anecdotes to find where people could meet openly or in secret.

BY **RYAN WILLIAMS** AND **ROSEMARY WARDLEY**

LGBTQ LOCATIONS

Year of establishment

- Before 1950
- 1950–1979
- 1980–1999
- 2000–2018

The Ramble in **Central Park** was a discreet place to meet for much of the 20th century.

Other historic centers of LGBTQ life beyond the borders of this map include Jackson Heights and Harlem.

By the mid-2000s, many new venues had opened in **Hell's Kitchen.**

Midtown's clubs and dance halls helped define the disco era in the 1970s.

"Fairy resorts" were located in the **Bowery,** which was popular with bohemians in the late 19th century.

Greenwich Village, home of the Stonewall Inn, hosts one of the world's largest pride parades.

Work in factories brought many lesbians to **Brooklyn** during World War II.

CENTRAL PARK

HELL'S KITCHEN

MIDTOWN

MANHATTAN

QUEENS

BROOKLYN

BOWERY

GREENWICH VILLAGE

Stonewall National Monument

Hudson River

East River

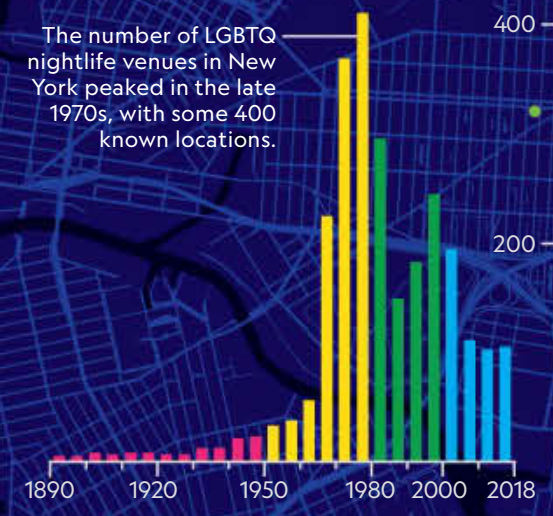
0 mi 1

0 km 1

AN EVOLVING SCENE

Average number of active locations documented per five-year period*

The number of LGBTQ nightlife venues in New York peaked in the late 1970s, with some 400 known locations.



Before 1950

Before World War II consumed cultural life, drag balls were openly attended by thousands, and many cafés and saloons central to "fairy" culture were in vogue.

1950–1979

As oppression of marginalized people and relationships reached a fever pitch after World War II, communities resisted with activism and open expression.

1980–1999

The rise of HIV/AIDS, which deeply affected the community, exacerbated a cultural backlash in the '80s and possibly led to a dip in nightlife locations.

2000–2018

As the community grows more connected through social media and other technology, some argue the pressure to meet in LGBTQ-specific venues has lessened.

Global Inspiration

In 2016 the Stonewall area was designated a national monument for its historic impact. This June, 50 years after the uprising, revelers from around the world will join New York City's annual pride events.

*DATA MAY NOT REPRESENT ALL LGBTQ NIGHTLIFE.

RILEY D. CHAMPINE, NGM STAFF. SOURCES: JEFF FERZOCO, OUTGOING NYC; GEORGE CHAUNCEY, COLUMBIA UNIVERSITY

Take Back Your Trails

PALE ALE FOR TRAILS®

Freedom's in the great outdoors. It's where we unplug to recharge, where we cut loose to feel most connected. But our favorite places to play are vulnerable. Their maintenance is underfunded while foot traffic keeps growing—a divergence that is wearing out our wild lands.

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Where Reptiles Rule

STORY AND PHOTOGRAPHS BY **THOMAS P. PESCHAK**

ON AN ISOLATED CORAL ATOLL, A PHOTOGRAPHER DISCOVERS A PRIMORDIAL PARADISE WHERE HE'S JUST PART OF THE ECOSYSTEM.

THE FIRST TIME A TORTOISE walked through my hut at Middle Camp on Aldabra Atoll, I was amazed. I grabbed my camera and carefully positioned myself to capture this wildlife encounter. The second time: same thing. The third time: I picked up my phone and took a snapshot. By the fourth or fifth time, I didn't even look when I felt something bump into me. I knew what it was.

I was there to shoot a story about island restoration in the Seychelles, far off the east coast of Africa in the Indian Ocean. Until roughly the middle of the past century, the small island nation showed signs of real environmental carnage—indigenous vegetation cleared to make way for coconut and cinnamon plantations, invasive rats and mice running rampant, native sea turtles and giant tortoises being exploited. Biodiversity seemed doomed.

But then the country experienced a shift in conservation consciousness—and the giant Aldabra tortoises are among its most visible signs. These massive reptiles lived on most islands in the Indian Ocean until 17th-century sailors discovered that they were the perfect source of fresh provisions on long voyages because they can survive for months without water or food. The mariners filled their holds with hundreds of tortoises at a time, flipping them on their backs to prevent them from wandering on deck. Little by little the tortoises on islands throughout the Indian Ocean were eaten to extinction—except on Aldabra, which was the only island in the entire ocean basin where a few thousand of these tortoises survived.

Aldabra's isolation and hostile environment protected the tortoises and does so still. Sitting more than 700 miles west of Mahé, the main island of the Seychelles, the island isn't on anyone's direct path.


SIMMS

(To get to it, I had to charter a propeller plane to the closest island with an airstrip and then take a small boat.) And Aldabra, one of the world's largest coral atolls, is quite inhospitable to visitors. The shoreline is razor-sharp coral rock. There's no permanent freshwater, but there are plenty of mosquitoes, and it's so hot that tortoises bake in their shells if they don't find shade during the day. Yet the tortoises thrive here because nobody was tough enough to go and get them—and because the atoll was designated in the 1980s as a special reserve by the government and as a natural World Heritage site by UNESCO. Protected from human interference, the population of tortoises has rebounded to roughly 100,000.

For two weeks of my six-week stay on Aldabra, I was based at Middle Camp, a daylong hike through hellish mangrove swamps from the research station run by the Seychelles Island Foundation. I lived in a hut with a dirt floor and a tin roof. At night coconut crabs scuttled across the roof to the sound of screeching metal.

Every morning when I woke up and walked outside the hut, I had to remind myself that I hadn't traveled back in time. I could see flightless Aldabra rails, coconut crabs the size of dinner plates, and giant tortoises—roughly four feet long and weighing up to 550 pounds—just wandering around. The number of sharks in the bay was insane. Frigatebirds and boobies nested in the mangroves.

The tortoises didn't seem to distinguish between me—a *National Geographic* photographer—and a frigatebird or a coconut crab or a flightless rail. We were all part of the ecosystem, and they treated humans as they treated every other creature: They ignored us. When we left our hut doors open, which we often did to let in air, the tortoises would walk right through. It didn't matter if we were cooking or sleeping or preparing camera gear. Our quarters were part of the daily migratory highway. When we sat on a small sandy patch behind the hut to eat, the tortoises would try to walk over us, almost bulldozing us out of the way. That's how much they feared humans.

In the late afternoon or early evening, whenever they'd finished grazing, the tortoises would plop down and fall asleep with their heads outstretched. That made nighttime trips to the outhouse perilous. To get there, we'd have to go 200 feet into the mangroves, negotiating what I called the tortoise slalom trail. It was a trail without a pattern, because of course they picked different places to sleep every night. Avoiding them was important: Falling headfirst over a tortoise onto the sharp coral rock could lead to serious injury on an island far from medical facilities.

Nothing was easy on Aldabra, and much of it was insanely difficult. Yet living among the tortoises in this primordial place, in one of the last spots where reptiles still rule, was one of the happiest times of my life. □

Photographer and marine biologist **Thomas Peschak** has shot nine feature stories for *National Geographic*. He specializes in documenting both the beauty and the fragility of the world's oceans, islands, and coastlines.

Giant tortoises can safely sleep with their heads and necks exposed on Aldabra Atoll, where they don't fear predators.

NGM MAPS

NATIONAL GEOGRAPHIC

SPECIAL REPORT

Wildlife Watch

IN OUR MISSION TO HELP PROTECT ANIMALS, WE EXAMINE NEW THREATS– HARMFUL SELFIE-DRIVEN TOURISM AND TRAFFICKING THAT ENDANGERS PANGOLINS– AS WELL AS **NEW HOPES** RAISED BY ZIMBABWE'S COURAGEOUS WOMEN RANGERS.

Wildlife Tourism **P. 44**

Pangolins at Risk **P. 78**

Brave Rangers **P. 102**

The Wildlife We See,

The Suffe

BY **NATASHA DALY** | PHOTOGRAPHS BY **KIRSTEN LUCE**

For $10, tourists can pose with this tiger at Phuket Zoo, in Thailand. Examples of souvenir photos are displayed here on a poster board.

The tiger is held by a short chain and can't stand up. Tigers

ring We Don't

HANDS-ON EXPERIENCES WITH EXOTIC ANIMALS ARE THRIVING, BOOSTED BY SOCIAL MEDIA.

may be declawed, or even drugged, to protect people around them.

IMAGES ON FLAPS

Photos of tourists with captive wild animals abound on social media platforms such as Instagram. With the tap of a finger, travelers post their images of exotic animals for the world to see. But often travelers and fans alike are unaware of what the animals' lives are really like.

RIGHT

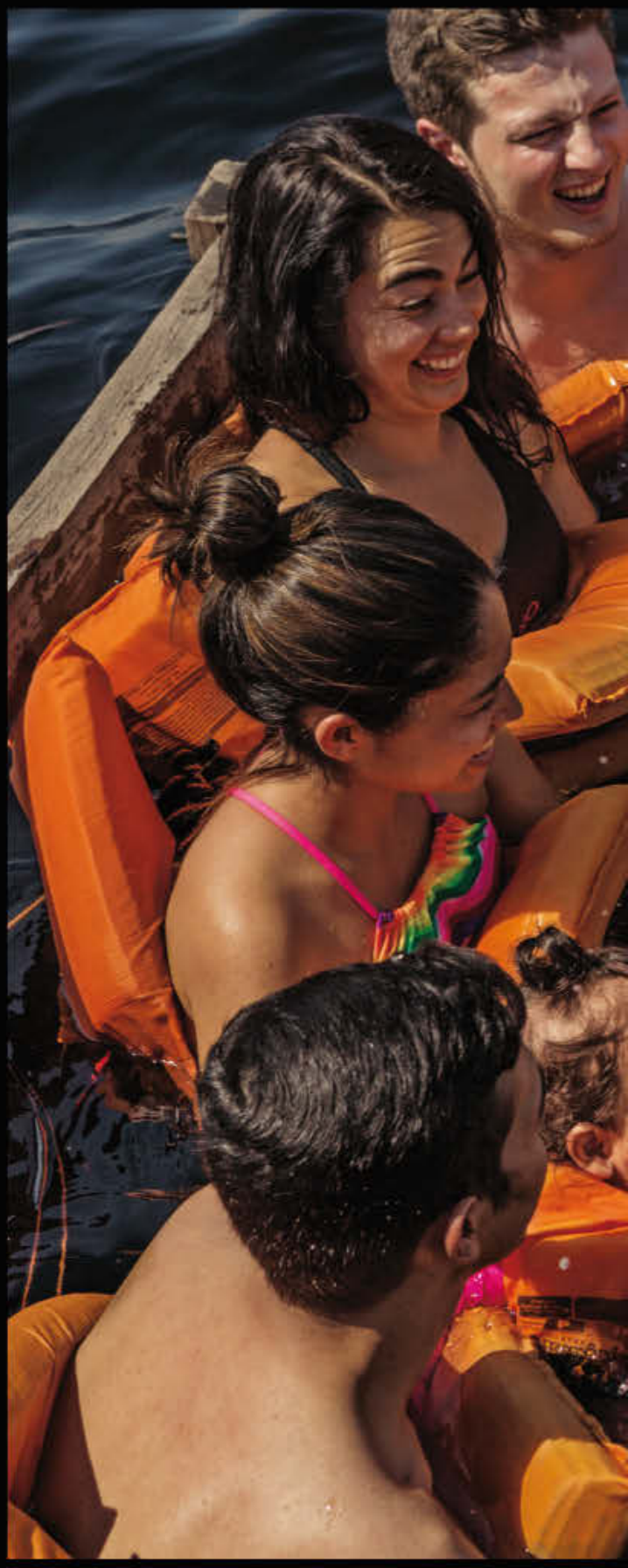
Muzzled and chained, three performing bears face their trainer, Grant Ibragimov, after a rehearsal at the Bolshoi State St. Petersburg Circus, in Russia. To make bear cubs strong enough to walk on two legs, trainers may keep them in a standing position, tethered by their necks to the wall.

FAR RIGHT

Gluay Hom, a four-year-old elephant trained to perform tricks for tourists, is chained to a pole in a stadium at Samut Prakan Crocodile Farm and Zoo near Bangkok, Thailand. His swollen right foreleg hangs limp. At his temple is a bloody wound from lying on the floor.

BUT BEHIND THE SCENES, ANIMALS INVOLVED IN TOURISM OFTEN LEAD MISERABLE LIVES.


Phi Phi Islands
1,011 likes
Monkey Beach lovers

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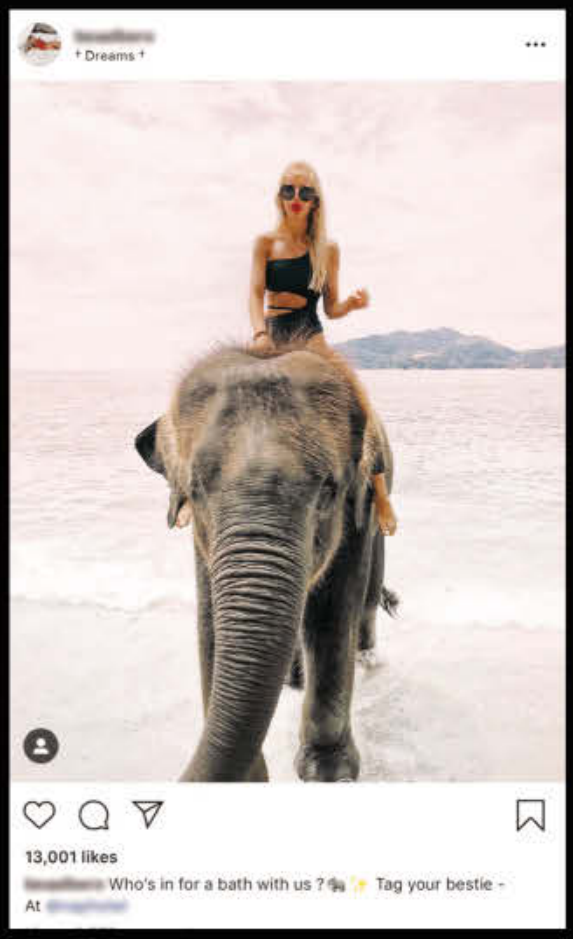

† Dreams †
13,001 likes
Who's in for a bath with us ?
Tag your bestie -
At

Tourists on the Rio Negro in Brazil swarm an Amazon dolphin lunging for a baitfish dangled by the tour operator. Many of the numerous scratches on the dolphin's skin are from brushes with other dolphins vying for bait. Hands-on wildlife encounters are popular in the region.

I've come back to check on a baby.

Just after dusk I'm in a car lumbering down a muddy road in the rain, past rows of shackled elephants, their trunks swaying. I was here five hours before, when the sun was high and hot and tourists were on elephants' backs.

Walking now, I can barely see the path in the glow of my phone's flashlight. When the wooden fence post of the stall stops me short, I point my light down and follow a current of rainwater across the concrete floor until it washes up against three large, gray feet. A fourth foot hovers above the surface, tethered tightly by a short chain and choked by a ring of metal spikes. When the elephant tires and puts her foot down, the spikes press deeper into her ankle.

Meena is four years and two months old, still a toddler as elephants go. Khammon Kongkhaw, her mahout, or caretaker, told me earlier that Meena wears the spiked chain because she tends to kick. Kongkhaw has been responsible for Meena here at Maetaman Elephant Adventure, near Chiang Mai, in northern Thailand, since she was 11 months old. He said he keeps her on the spiked shackle only during the day and takes it off at night. But it's night now.

I ask Jin Laoshen, the Maetaman staffer accompanying me on this nighttime visit, why her chain is still on. He says he doesn't know.

Maetaman is one of many animal attractions in and around tourist-swarmed Chiang Mai.

Tourists pose with elephants at Maetaman Elephant Adventure, near Chiang Mai, Thailand. Young elephants often perform tricks; older ones give rides. To make elephants compliant for human interactions, juveniles are "broken"—trained with painful jabs from a metal hook.

People spill out of tour buses and clamber onto the trunks of elephants that, at the prodding of their mahouts' bullhooks (long poles with a sharp metal hook), hoist them in the air while cameras snap. Visitors thrust bananas toward elephants' trunks. They watch as mahouts goad their elephants—some of the most intelligent animals on the planet—to throw darts or kick oversize soccer balls while music blares.

Meena is one of Maetaman's 10 show elephants. To be precise, she's a painter. Twice a day, in front of throngs of chattering tourists, Kongkhaw puts a paintbrush in the tip of her trunk and presses a steel nail to her face to direct her brushstrokes as she drags primary colors across paper. Often he guides her to paint a wild elephant in the savanna. Her paintings are then sold to tourists.

Meena's life is set to follow the same trajectory as many of the roughly 3,800 captive elephants in Thailand and thousands more throughout Southeast Asia. She'll perform in shows until she's about 10. After that, she'll become a riding elephant. Tourists will sit on a bench strapped to her back, and she'll give several rides a day. When Meena is too old or sick to give rides—maybe at 55, maybe at 75—she'll die. If she's lucky, she'll get a few years of retirement. She'll spend most of her life on a chain in a stall.

Wildlife attractions such as Maetaman lure people from around the world to be with animals

The nonprofit National Geographic Society helped fund this story. To read more reporting by Wildlife Watch, visit *natgeo.com/wildlife-watch*.

A macaque pauses during a performance at Monkey School, a roadside zoo near Chiang Mai. The monkeys are trained to ride a tricycle, shoot a basketball, twirl a parasol. After the shows, they're returned to roughly three-by-three-foot metal cages.

In a photo studio at Samut Prakan Crocodile Farm and Zoo, an employee changes a young chimpanzee's diaper before putting him back on a chain. On a short chain in the other corner is Khai Khem, an elderly tiger with a tooth abscess rotting his jaw. Visitors pay to take pictures with the animals.

like Meena, and they make up a lucrative segment of the booming global travel industry. Twice as many trips are being taken abroad as 15 years ago, a jump driven partly by Chinese tourists, who spend far more on international travel than any other nationality.

Wildlife tourism isn't new, but social media is setting the industry ablaze, turning encounters with exotic animals into photo-driven bucket-list toppers. Activities once publicized mostly in guidebooks now are shared instantly with multitudes of people by selfie-taking backpackers, tour-bus travelers, and social media "influencers" through a tap on their phone screens. Nearly all millennials (23- to 38-year-olds) use social media while traveling. Their selfies—of swims with dolphins, encounters with tigers, rides on elephants, and more—are viral advertising for attractions that tout up-close experiences with animals.

For all the visibility social media provides, it doesn't show what happens beyond the view of the camera lens. People who feel joy and exhilaration from getting close to wild animals usually are unaware that many of the animals at such attractions live a lot like Meena, or worse.

Photographer Kirsten Luce and I set out to look behind the curtain of the thriving wildlife tourism industry, to see how animals at various attractions—including some that emphasize their humane care of animals—are treated once the selfie-taking crowds have gone.

AFTER LEAVING Maetaman, we take a five-minute car ride up a winding hill to a property announced by a wooden plaque as "Elephant EcoValley: where elephants are in good hands." There are no elephant rides here. No paint shows or other performances. Visitors can stroll through an open-air museum and learn about Thailand's national animal. They can make herbal treats for the elephants and paper from elephant dung. They can watch elephants in a grassy, tree-ringed field.

EcoValley's guest book is filled with praise from Australians, Danes, Americans—tourists who often shun elephant camps such as Maetaman because the rides and shows make them uneasy. Here, they can see unchained elephants and leave feeling good about supporting what they believe is an ethical establishment. What many don't know is that EcoValley's seemingly carefree elephants are brought here for the

At Sriracha Tiger Zoo, in Chon Buri, Thailand, cubs taken from their mothers at birth are kept in small cages and brought out for photo ops. Mothers are speed bred to ensure that there are always baby cats for visitors to cuddle.

day from nearby Maetaman—and that the two attractions are actually a single business.

Meena was brought here once, but she tried to run into the forest. Another young elephant, Mei, comes sometimes, but today she's at Maetaman, playing the harmonica in the shows. When she's not doing that, or spending the day at EcoValley, she's chained near Meena in one of Maetaman's elephant stalls.

Meena Kalamapijit owns Maetaman as well as EcoValley, which she opened in November 2017 to cater to Westerners. She says her 56 elephants are well cared for and that giving rides and performing allow them to have necessary exercise. And, she says, Meena the elephant's behavior has gotten better since her mahout started using the spiked chain.

We sit with Kalamapijit on a balcony outside her office, and she explains that when Westerners, especially Americans, stopped coming to Maetaman, she eliminated one of the daily shows to allot time for visitors to watch elephants bathe in the river that runs through the camp.

"Westerners enjoy bathing because it looks happy and natural," she says. "But a Chinese tour agency called me and said, 'Why are you cutting the show? Our customers love to see it, and they don't care about bathing at all.'" Providing separate options is good for business, Kalamapijit says.

Around the world Kirsten and I watched tourists watching captive animals. In Thailand we also saw American men bear-hug tigers in Chiang Mai and Chinese brides in wedding gowns ride young elephants in the aqua surf on the

island of Phuket. We watched polar bears in wire muzzles ballroom dancing across the ice under a big top in Russia and teenage boys on the Amazon River snapping selfies with baby sloths.

Most tourists who enjoy these encounters don't know that the adult tigers may be declawed, drugged, or both. Or that there are always cubs for tourists to snuggle with because the cats are speed bred and the cubs are taken from their mothers just days after birth. Or that the elephants give rides and perform tricks without harming people only because they've been "broken" as babies and taught to fear the bullhook. Or that the Amazonian sloths taken illegally from the jungle often die within weeks of being put in captivity.

As we traveled to performance pits and holding pens on three continents and in the Hawaiian Islands, asking questions about how animals are treated and getting answers that didn't always add up, it became clear how methodically and systematically animal suffering is concealed.

THE INDUSTRY CATERS TO PEOPLE'S LOVE OF ANIMALS **BUT OFTEN SEEKS TO MAXIMIZE PROFITS BY EXPLOITING THOSE ANIMALS FROM BIRTH TO DEATH.**

The wildlife tourism industry caters to people's love of animals but often seeks to maximize profits by exploiting animals from birth to death. The industry's economy depends largely on people believing that the animals they're paying to watch or ride or feed are having fun too.

It succeeds partly because tourists—in unfamiliar settings and eager to have a positive experience—typically don't consider the possibility that they're helping to hurt animals. Social media adds to the confusion: Oblivious endorsements from friends and trendsetters legitimize attractions before a traveler ever gets near an animal.

There has been some recognition of social media's role in the problem. In December 2017, after a National Geographic investigative report on harmful wildlife tourism in Amazonian Brazil and Peru, Instagram introduced a feature: Users who click or search one of dozens of hashtags, such as #slothselfie and #tigercubselfie, now get a pop-up warning that the content they're viewing may be harmful to animals.

EVERYONE FINDS Olga Barantseva on Instagram. "Photographer from Russia. Photographing dreams," her bio reads. She meets clients for woodland photo shoots with captive wild animals just outside Moscow.

For her 18th birthday, Sasha Belova treated herself to a session with Barantseva—and a pack of wolves. "It was my dream," she says as she fidgets with her hair, which had been styled that morning. "Wolves are wild and dangerous." The wolves are kept in small cages at a petting zoo when not participating in photo shoots.

The Kravtsov family hired Barantseva to take their first professional family photos—all five family members, shivering and smiling in the birch forest, joined by a bear named Stepan.

Barantseva has been photographing people and wild animals together for six years. She "woke up as a star," she says, in 2015, when a couple of international media outlets found her online. Her audience has exploded to more than 80,000 followers worldwide. "I want to show harmony between people and animals," she says.

On a raw fall day, under a crown of golden birch leaves on a hill that overlooks a frigid lake, two-and-a-half-year-old Alexander Levin, dressed in a hooded bumblebee sweater, timidly holds Stepan's paw.

The bear's owners, Yury and Svetlana Panteleenko, ply their star with food—tuna fish mixed with oatmeal—to get him to approach the boy. *Snap:* It looks like a tender friendship. The owners toss grapes to Stepan to get him to open his mouth wide. *Snap:* The bear looks as if he's smiling.

The Panteleenkos constantly move Stepan, adjusting his paws, feeding him, and positioning Alexander as Barantseva, pink-haired, bundled in jeans and a parka, captures each moment. *Snap:* A photo goes to her Instagram feed. A boy and a bear in golden Russian woods—a picture straight out of a fairy tale. It's a contemporary twist on a long-standing Russian tradition of exploiting bears for entertainment.

Another day in the same forest, Kirsten and I join 12 young women who have nearly identical

Instagram accounts replete with dreamy photos of models caressing owls and wolves and foxes. Armed with fancy cameras but as yet modest numbers of followers, they all want the audience Barantseva has. Each has paid the Panteleenkos $760 to take identical shots of models with the ultimate prize: a bear in the woods.

Stepan is 26 years old, elderly for a brown bear, and can hardly walk. The Panteleenkos say they bought him from a small zoo when he was three months old. They say the bear's work—a constant stream of photo shoots and movies—provides money to keep him fed.

A video on Svetlana Panteleenko's Instagram account proclaims: "Love along with some great food can make anyone a teddy :-)"

And just like that, social media takes a single instance of local animal tourism and broadcasts it to the world.

WHEN THE DOCUMENTARY FILM *Blackfish* was released in 2013, it drew a swift and decisive reaction from the American public. Through the story of Tilikum, a distressed killer whale at SeaWorld in Orlando, Florida, the film detailed the miserable life orcas can face in captivity. Hundreds of thousands of outraged viewers signed petitions. Companies with partnership deals, such as Southwest Airlines, severed ties with SeaWorld. Attendance at SeaWorld's water parks slipped; its stock nose-dived.

James Regan says what he saw in *Blackfish* upset him. Regan, honeymooning in Hawaii with his wife, Katie, is from England, where the country's last marine mammal park closed permanently in 1993. I meet him at Dolphin Quest Oahu, an upscale swim-with-dolphins business on the grounds of the beachfront Kahala Hotel & Resort, just east of Honolulu. The Regans paid $225 each to swim for 30 minutes in a small group with a bottlenose dolphin. One of two Dolphin Quest locations in Hawaii, the facility houses six dolphins.

Bottlenose dolphins are the backbone of an industry that spans the globe. Swim-with-dolphins operations rely on captive-bred and wild-caught dolphins that live—and interact with tourists—in pools. The popularity of these photo-friendly attractions reflects the disconnect around dolphin experiences: People in the West increasingly shun shows that feature animals performing tricks, but many see swimming with captive dolphins as a vacation rite of passage.

Katie Regan has wanted to swim with dolphins since she was a child. Her husband laughs and says of Dolphin Quest, "They paint a lovely picture. When you're in America, everyone is smiling." But he appreciates that the facility is at their hotel, so they can watch the dolphins being fed and cared for. He brings up *Blackfish* again.

Katie protests: "Stop making my dream a horrible thing!"

Rae Stone, president of Dolphin Quest and a marine mammal veterinarian, says the company donates money to conservation projects and educates visitors about perils that marine mammals face in the wild. By paying for this entertainment, she says, visitors are helping captive dolphins' wild cousins.

Stone notes that Dolphin Quest is certified "humane" by American Humane, an animal welfare nonprofit. (The Walt Disney Company, *National Geographic*'s majority owner, offers dolphin encounters on some vacation excursions and at an attraction in Epcot, one of its Orlando parks. Disney says it follows the animal welfare standards of the Association of Zoos & Aquariums, a nonprofit that accredits more than 230 facilities worldwide.)

It's a vigorous debate: whether even places with high standards, veterinarians on staff, and features such as pools filled with filtered ocean water can be truly humane for marine mammals.

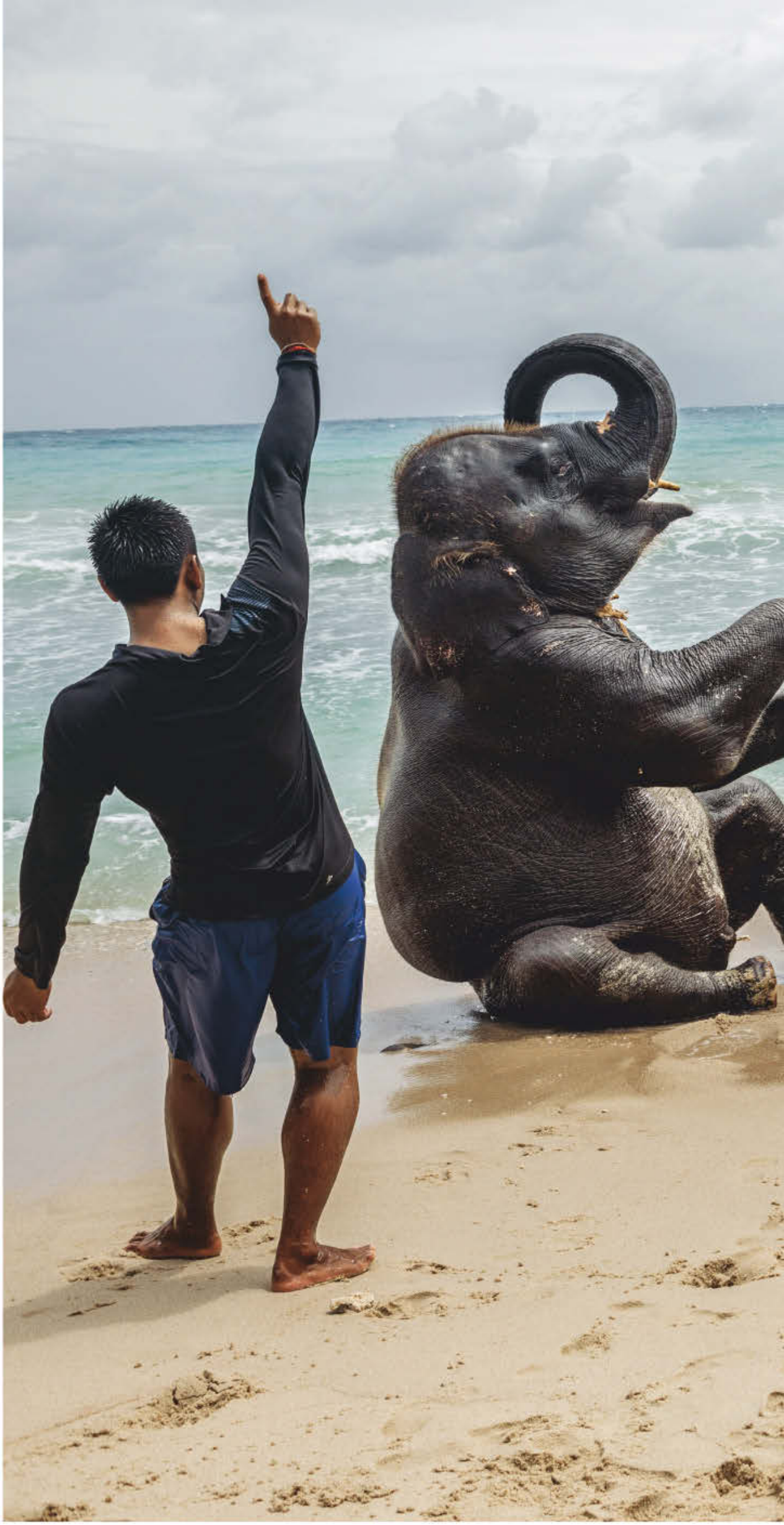
Dolphin Quest's Stone says yes.

Critics, including the Humane Society of the United States, which does not endorse keeping dolphins in captivity, say no. They argue that these animals have evolved to swim great distances and live in complex social groups—conditions that can't be replicated in the confines of a pool. This helps explain why the National Aquarium, in Baltimore, announced in 2016 that its dolphins will be retired to a seaside sanctuary by 2020.

Some U.S. attractions breed their own dolphins because the nation has restricted dolphin catching in the wild since 1972. But elsewhere, dolphins are still being taken from the wild and turned into performers.

In China, which has no national laws on captive-animal welfare, dolphinariums with wild-caught animals are a booming business: There are now 78 marine mammal parks, and 26 more are under construction.

TOURISTS SEE ELEPHANTS GIVING RIDES AND DOING TRICKS. **THEY DON'T SEE THE ANIMALS BEING 'BROKEN' AND TAUGHT TO FEAR THE BULLHOOK.**



A British family enjoys a photo shoot with juvenile elephants at Lucky Beach on the island of Phuket. Many travelers, unaware of the training the elephants endure, view such picturesque experiences as the highlight of their trip. Thailand has some 3,800 captive elephants. More than half work in the tourism industry.

TO HAVE THE once-in-a-lifetime chance to see rare Black Sea dolphins, people in the landlocked town of Kaluga, a hundred miles from Moscow, don't have to leave their city. In the parking lot of the Torgoviy Kvartal shopping mall, next to a hardware store, is a white inflatable pop-up aquarium: the Moscow Traveling Dolphinarium. It looks like a children's bouncy castle that's been drained of its color.

Inside the puffy dome, parents buy their kids dolphin-shaped trinkets: fuzzy dolls and Mylar balloons, paper dolphin hats, and drinks in plastic dolphin tumblers. Families take their seats around a small pool. The venue is so intimate that even the cheapest seats, at nine dollars apiece, are within splashing distance.

"My kids are jumping for joy," says a woman named Anya, motioning toward her two giddy boys, bouncing in their seats.

In the middle of the jubilant atmosphere, in water that seems much too shallow and much too murky, two dolphins swim listlessly in circles.

Russia is one of only a few countries (Indonesia is another) where traveling oceanariums exist. Dolphins and beluga whales, which need to be immersed in water to stay alive, are put in tubs on trucks and carted from city to city in a loop that usually ends when they die. These traveling shows are aboveboard: Russia has no laws that regulate how marine mammals should be treated in captivity.

The shows are the domestic arm of a brisk Russian global trade in dolphins and small whales.

Tourists take turns snapping photos with a pygmy slow loris at a floating river market near Bangkok. The nocturnal primates are mostly poached from the wild. Their sharp teeth are cut off or extracted to safeguard people from the animals' venomous bite.

Black Sea bottlenose dolphins can't be caught legally without a permit, but Russian fishermen can catch belugas and orcas under legal quotas in the name of science and education. Some belugas are sold legally to aquariums around the country. Russia now allows only a dozen or so orcas to be caught each year for scientific and educational purposes, and since April 2018, the government has cracked down on exporting them. But government investigators believe that Russian orcas—which can sell for millions—are being caught illegally for export to China.

Captive orcas, which can grow to 20 feet long and more than 10,000 pounds, are too big for the traveling shows that typically feature dolphins and belugas. When I contacted the owners of the Moscow Traveling Dolphinarium and another operation, the White Whale Show, in separate telephone calls to ask where their dolphins and belugas come from, both men, Sergey Kuznetsov and Oleg Belesikov, hung up on me.

Russia's dozen or so traveling oceanariums are touted as a way to bring native wild animals to people who might never see the ocean.

"Who else if not us?" says Mikhail Olyoshin, a staffer at one traveling oceanarium. And on this day in Kaluga, as the dolphins perform tricks to American pop songs and lie on platforms for several minutes for photo ops, parents and children express the same sentiment: Imagine, dolphins, up close, in my hometown. The ocean on delivery.

OWNERS AND OPERATORS of wildlife tourism attractions, from high-end facilities such as Dolphin Quest in Hawaii to low-end monkey shows in Thailand, say their animals live longer in captivity than wild counterparts because they're safe from predators and environmental hazards. Show operators proudly emphasize that the animals under their care are with them for life. They're family.

Alla Azovtseva, a longtime dolphin trainer in Russia, shakes her head.

"I don't see any sense in this work. My conscience bites me. I look at my animals and want to cry," says Azovtseva, who drives a red van with dolphins airbrushed on the side. At the moment, she's training pilot whales to perform tricks at Moscow's Moskvarium, one of Europe's largest aquariums (not connected to the traveling dolphin shows). On her day off, we meet at a café near Red Square.

THE DEMAND FOR EXOTIC ANIMALS THAT TOURISTS CAN TOUCH HAS LED TO ANIMALS BEING TAKEN ILLEGALLY FROM THE WILD. **SOME, SUCH AS AMAZONIAN SLOTHS, TYPICALLY DIE AFTER WEEKS OR MONTHS IN CAPTIVITY.**

On a platform in Puerto Alegría, a tiny Peruvian town on the banks of the Amazon River, tourists visit a one-stop wildlife menagerie. This anteater, which was on a diet that included flavored yogurt, is one of dozens of animals caught illegally in the jungle for tourist photos. Last December, authorities rescued 22 animals from the town. They didn't find the anteater.

Beluga whales perform in a pop-up aquarium under an inflatable tent in Saratov, Russia. Not all wildlife tourism entails going to exotic destinations: Traveling shows bring marine animals to people in small cities throughout Russia. Belugas, which are caught from Russian waters, don't live long in these conditions.

Behind netting, a polar bear dances at the Circus on Ice in Kazan, Russia. Performing polar bears are extremely rare. The show's four bears wear metal muzzles, and their trainer, Yulia Denisenko, carries a metal rod. Between tricks, the bears lie down and rub themselves on the ice.

She says she fell in love with dolphins in the late 1980s when she read a book by John Lilly, the American neuroscientist who broke open our understanding of the animals' intelligence. She has spent 30 years training marine mammals to do tricks. But along the way she's grown heartsick from forcing highly intelligent, social creatures to live isolated, barren lives in small tanks.

"I would compare the dolphin situation with making a physicist sweep the street," she says. "When they're not engaged in performance or training, they just hang in the water facing down. It's the deepest depression."

What people don't know about many aquarium shows in Russia, Azovtseva says, is that the animals often die soon after being put in captivity, especially those in traveling shows. And Azovtseva—making clear she's referring to the industry at large in Russia and not the Moskvarium—says she knows many aquariums quietly and illegally replace their animals with new ones.

It's been illegal to catch Black Sea dolphins in the wild for entertainment purposes since 2003, but according to Azovtseva, aquarium owners who want to increase their dolphin numbers quickly and cheaply buy dolphins poached there. Because these dolphins are acquired illegally, they're missing the microchips that captive cetaceans in Russia are usually tagged with as a form of required identification.

Some aquariums get around that, she says, by cutting out dead dolphins' microchips and implanting them into replacement dolphins.

"People are people," Azovtseva says. "Once they see an opportunity, they exploit." She says she can't go on doing her work in the industry and that she's decided to speak out because she wants people to know the truth about the origins and treatment of many of the marine mammals they love watching. We exchange a look—we both know what her words likely mean for her livelihood.

"I don't care if I'm fired," she says defiantly. "When a person has nothing to lose, she becomes really brave."

I'M SITTING on the edge of an infinity pool on the hilly Thai side of Thailand's border with Myanmar, at a resort where rooms average more than a thousand dollars a night.

Out past the pool, elephants roam in a lush valley. Sitting next to me is 20-year-old

In a forest outside Moscow, Stepan, a 26-year-old brown bear and social media star, sits between an angel-wing-clad model and his owner, Svetlana Panteleenko. Moscow-based photographers pay $760 each to capture the scene for their Instagram feeds.

Stephanie van Houten. She's Dutch and French, Tokyo born and raised, and a student at the University of Michigan. Her cosmopolitan background and pretty face make for a perfect cocktail of aspiration—she's exactly the kind of Instagrammer who makes it as an influencer. That is, someone who has a large enough following to attract sponsors to underwrite posts and, in turn, travel, wardrobes, and bank accounts. In 2018, brands—fashion, travel, tech, and more—spent an estimated $1.6 billion on social media advertising by influencers.

Van Houten has been here, at the Anantara Golden Triangle Elephant Camp & Resort, before. This time, in a fairly standard influencer-brand arrangement, she'll have a picnic with elephants and post about it to her growing legion of more than 25,000 Instagram followers. In exchange, she gets hundreds of dollars off the nightly rate.

At Anantara the fields are green, and during the day at least, many of the resort's 22 elephants are tethered on ropes more than a hundred feet long so they can move around and socialize. Nevertheless, they're expected to let guests touch them and do yoga beside them.

After van Houten's elephant picnic, I watch her edit the day's hundreds of photos. She selects an image with her favorite elephant, Bo. She likes it, she says, because she felt a connection with Bo and thinks that will come across. She posts it at 9:30 p.m.—the time she estimates the largest number of her followers will be online. She includes a long caption, summing it up as "my

love story with this incredible creature," and the hashtag #stopelephantriding. Immediately, likes from followers stream in—more than a thousand, as well as comments with heart-eyed emoji.

Anantara is out of reach for anyone but the wealthy—or prominent influencers. Anyone else seeking a similar experience might do a Google search for, say, "Thailand elephant sanctuary."

As tourist demand for ethical experiences with animals has grown, affordable establishments, often calling themselves "sanctuaries," have cropped up purporting to offer humane, up-close elephant encounters. Bathing with elephants—tourists give them a mud bath, splash them in a river, or both—has become very popular. Many facilities portray baths as a benign alternative to elephant riding and performances. But elephants getting baths, like those that give rides and do tricks, will have been broken to some extent to make them obedient. And as long as bathing remains popular, places that offer it will need obedient elephants to keep their businesses going.

IN BAN TA KLANG, a tiny town in eastern Thailand, modest homes dot the crimson earth. In front of each is a wide, bamboo platform for sitting, sleeping, and watching television.

But the first thing I notice is the elephants. Some homes have one, others as many as five. Elephants stand under tarps or sheet metal roofs or trees. Some are together, mothers and babies, but most are alone. Nearly all the elephants wear ankle chains or hobbles—cuffs binding their front legs together. Dogs and chickens weave among the elephants' legs, sending up puffs of red dust.

Ban Ta Klang—known as Elephant Village—is ground zero in Thailand for training and trading captive elephants.

"House elephants," Sri Somboon says, gesturing as he turns down his TV. Next to his outdoor platform, a two-month-old baby elephant runs around his mother. Somboon points across the road to the third elephant in his charge, a three-year-old male tethered to a tree. He's wrenching his head back and forth and thrashing his trunk around. It looks as if he's going out of his mind.

He's in the middle of his training, Somboon says, and is getting good at painting. He's already been sold, and when his training is finished, he'll start working at a tourist camp down south.

Ban Ta Klang and the surrounding area, part of Surin Province, claim to be the source of more than half of Thailand's 3,800 captive elephants. Long before the flood of tourists, it was the center of the elephant trade; the animals were caught in the wild and tamed for use transporting logs. Now, every November, hundreds of elephants from here are displayed, bought, and sold in the province's main town, Surin.

One evening I sit with Jakkrawan Homhual and Wanchai Sala-ngam. Both 33, they've been best friends since childhood. About half the people in Ban Ta Klang who care for elephants, including Homhual, don't own them. They're paid a modest salary by a rich owner to breed and train baby elephants for entertainment. As night falls, thousands of termites swarm us, attracted to the single bulb hanging above the bamboo platform. Our conversation turns to elephant training.

Phajaan is the traditional—and brutal—days- or weeks-long process of breaking a young elephant's spirit. It has long been used in Thailand and throughout Southeast Asia to tame wild elephants, which still account for many of the country's captives. Under phajaan, elephants are bound with ropes, confined in tight wooden structures, starved, and beaten repeatedly with bullhooks, nails, and hammers until their will is crushed. The extent to which phajaan persists in its harshest form is unclear. Since 2012, the government has been cracking down on the illegal import of elephants taken from the forests of neighboring Myanmar, Thailand's main source of wild-caught animals.

I ask the men how baby elephants born in captivity are broken and trained.

When a baby is about two years old, they say, mahouts tie its mother to a tree and slowly drag the baby away. Once separated, the baby is confined. Using a bullhook on its ear, they teach the baby to move: left, right, turn, stop. To teach an elephant to sit, Sala-ngam says, "we tie up the front legs. One mahout will use a bullhook at the back. The other will pull a rope on the front legs." He adds: "To train the elephant, you need to use the bullhook so the elephant will know."

Humans identify suffering in other humans by universal signs: People sob, wince, cry out, put voice to their hurt. Animals have no universal language for pain. Many animals don't have tear ducts. More creatures still—prey animals, for example—instinctively mask symptoms of pain, lest they appear weak to predators.

Recognizing that a nonhuman animal is in pain is difficult, often impossible.

But we know that animals feel pain. All mammals have a similar neuroanatomy. Birds, reptiles, and amphibians all have pain receptors. As recently as a decade ago, scientists had collected more evidence that fish feel pain than they had for neonatal infants. A four-year-old human child with spikes pressing into his flesh would express pain by screaming. A four-year-old elephant just stands there in the rain, her leg jerking in the air.

OF ALL THE silently suffering animals I saw in pools and pens around the world, two in particular haunt me: an elephant and a tiger.

They lived in the same facility, Samut Prakan Crocodile Farm and Zoo, about 15 miles south of Bangkok. The elephant, Gluay Hom, four years old, was kept under a stadium. The aging tiger, Khai Khem, 22, spent his days on a short chain in a photo studio. Both had irrefutable signs of suffering: The emaciated elephant had a bent, swollen leg hanging in the air and a large, bleeding sore at his temple. His eyes were rolled back in his head. The tiger had a dental abscess so severe that the infection was eating through the bottom of his jaw.

When I contacted the owner of the facility, Uthen Youngprapakorn, to ask about these animals, he said the fact that they hadn't died proved that the facility was caring for them properly. He then threatened a lawsuit.

Six months after Kirsten and I returned from Thailand, we asked Ryn Jirenuwat, our Bangkok-based Thai interpreter, to check on Gluay Hom and Khai Khem. She went to Samut Prakan and watched them for hours, sending photos and video. Gluay Hom was still alive, still standing in the same stall, leg still bent at an unnatural angle. The elephants next to him were skin and bones. Khai Khem was still chained by his neck to a hook in the floor. He just stays in his dark corner, Jirenuwat texted, and when he hears people coming, he twists on his chain and turns his back to them.

"Like he just wants to be swallowed by the wall." ▯

Natasha Daly is a staff writer and editor at *National Geographic*. **Kirsten Luce** is a freelance photographer based in New York. They traveled together through six countries to report this story.

Some guidelines for seeing wild animals

Figuring out how to observe exotic animals humanely can be complicated and confusing. Watching them from a safe distance in the wild is ideal, animal welfare advocates say. To assess how facilities treat captive animals, you can refer to internationally recognized standards inspired by a 1965 U.K. government report. Known as the "five freedoms," they're used by animal welfare groups worldwide and by the U.S., Canadian, and European veterinary medical associations.

1 Freedom from hunger and thirst
Look for facilities where animals appear to be well-fed and have access to clean water at all times.

2 Freedom from discomfort
Observe whether animals have an appropriate environment, including shelter, ample space, a comfortable resting area, and a secluded place away from crowds.

3 Freedom from pain, injury, or disease
Avoid facilities where animals are visibly injured or are forced to participate in activities that could injure them or cause them pain—or where enclosures aren't clean.

4 Freedom to express normal behavior
Being chained, performing, and interacting with tourists—giving rides, posing with them, being washed by them—are not normal for a wild animal, even one born in captivity.

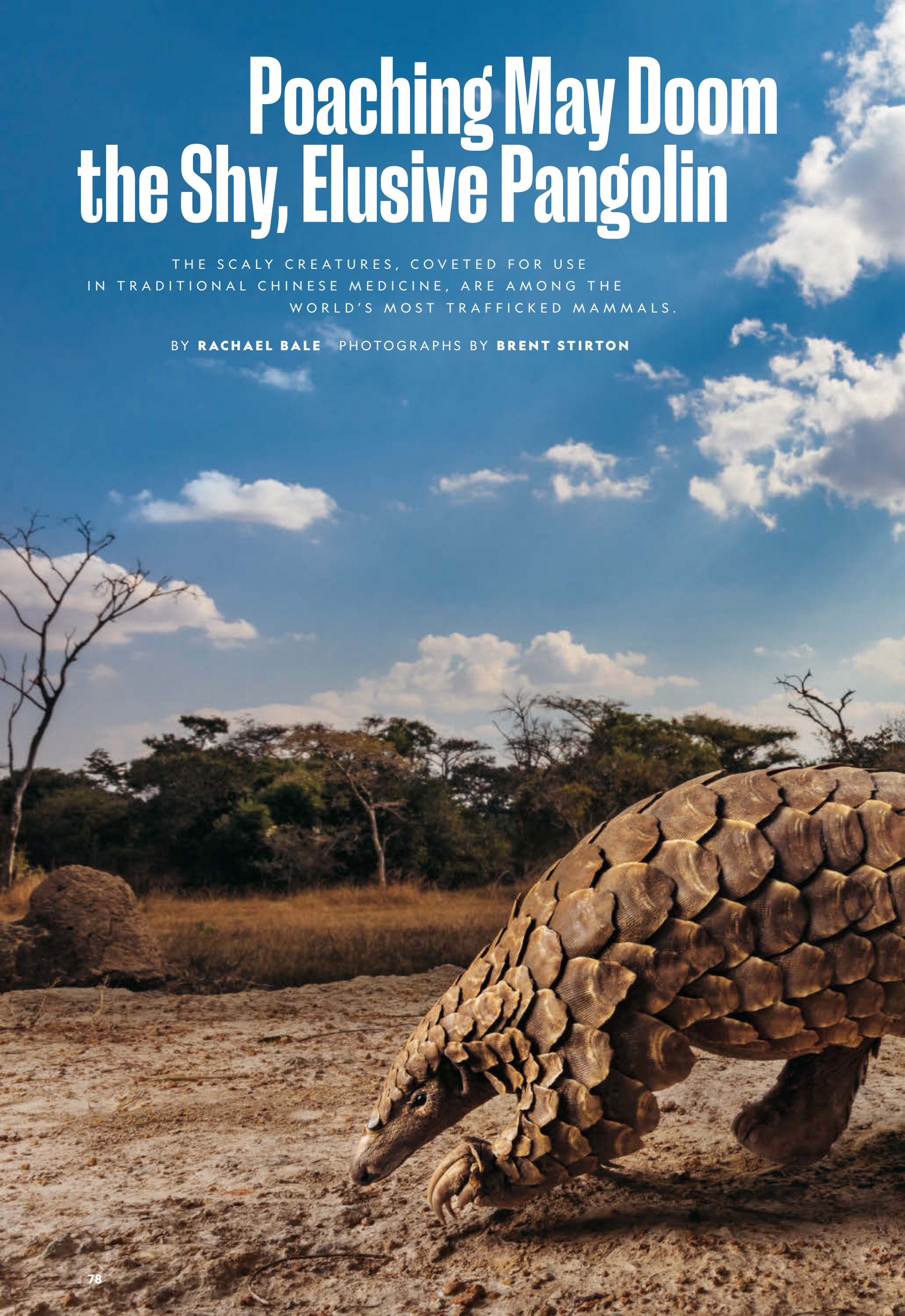
5 Freedom from fear and distress
Be aware that fear-based training, separation of babies from mothers at birth, unnatural noises, and large crowds cause distress.

To learn more, visit *natgeo.com/wildlifetourism*.

Poaching May Doom the Shy, Elusive Pangolin

THE SCALY CREATURES, COVETED FOR USE IN TRADITIONAL CHINESE MEDICINE, ARE AMONG THE WORLD'S MOST TRAFFICKED MAMMALS.

BY **RACHAEL BALE** PHOTOGRAPHS BY **BRENT STIRTON**



A Temminck's ground pangolin named Tamuda searches for a meal of ants or termites at a rehabilitation center in Zimbabwe. He was rescued from illegal wildlife traders, who likely would have smuggled his scales to Asia for use in traditional remedies.

Pangolins are trafficked both for their scales and meat, considered by some to be a delicacy. In April 2015 more than 4,000 frozen pangolin carcasses, along with scales and nearly a hundred live animals, were discovered in Indonesia in a shipping container supposedly holding frozen fish.

PAUL HILTON

Masked to protect their identities, law enforcement officers with Côte d'Ivoire's organized crime unit sit atop nearly 8,000 pounds of pangolin scales seized in 2017 and 2018 and probably bound for China or Vietnam. As the four Asian pangolin species have become endangered, traffickers have turned to the African species.


U.C.T
Unité de lutte contre la Criminalité
Transnationale organisée.

He's the size of a golden retriever puppy and covered with scales.

At the Tikki Hywood Foundation's rescue center, in Zimbabwe, each pangolin—like Tamuda, seen here—is assigned a caretaker. The pangolins form close bonds with their humans, who help them learn how to feed on ants and termites. Rescued as a baby, Tamuda was stubborn and impish, his caretaker says.

With his tail stretched out parallel to the ground for balance, Tamuda holds his little arms in front of him like a *T. rex*.

The caretaker gently guides the young pangolin toward a dirt mound that he starts to break apart with a pick. Look, he encourages Tamuda: ants. Tamuda catches on and begins to eat, his nearly body-length tongue searching the crevices, his long claws mimicking the pick.

After a few minutes of eating, it's time to move on. Tamuda lumbers a little farther. The caretaker shows him a new ant mound. This time the pangolin isn't interested. He flops on his side like a toddler about to throw a tantrum. He curls his body around the boot of the caretaker, who bends down and gently tries to peel him off, but Tamuda wants attention.

Looking up into his human's face, he reaches high, begging to be picked up. The caretaker tries to be strict—he's supposed to be teaching Tamuda how to fend for himself—but the plea is too much to resist. As any good pangolin mother would do, he lifts Tamuda up and cradles him.

Tamuda's lesson was taking place at the Tikki Hywood Foundation, a rescue center near Harare, Zimbabwe, where pangolins freed from

the illegal wildlife trade by Lisa Hywood and her team recover.

Hywood—a fiery, compact woman prone to alternating between cooing lullabies to her rescues and vociferously condemning the cruelty of man—has rescued more than 180 pangolins since 2012. Tikki Hywood is also home to rescued sable antelope, cows, a feisty goat, and a pair of donkeys named Jesus and Mary. (Joseph is no longer with us.)

Young pangolins like being up high. Until they're several months old, their mothers carry them on their backs so the babies can observe how to behave. That's probably where Tamuda was spending most of his time just before poachers snatched him and his mother from the wild. When a pangolin mother is afraid, she rolls into a ball, protecting her soft, peach-fuzz belly and her baby with the armor of her scales. It's good defense against a lion, but it's about the worst thing to do when your predator is a human and can scoop you up with bare hands.

Tamuda and his mother came to the rescue center in early 2017. A Zimbabwe border patrol officer caught a man from Mozambique trying to cross into the country with them in a sack. According to the wildlife trade monitoring organization Traffic, an estimated one million pangolins

The nonprofit National Geographic Society helped fund this story. To read more reporting by Wildlife Watch, visit *natgeo.com/wildlife-watch*.

Pangolins are usually solitary, but Tamuda and Luleko spend a rare moment near each other to take a drink from a puddle. Temminck's ground pangolins walk on their back legs, using their tails and front legs for balance. Their sticky tongues, almost as long as their bodies, are anchored at the base of their rib cages.

In Cameroon a young woman who runs a food stall prepares to butcher a white-bellied pangolin in the alley behind her home. Cameroonians have long eaten the animals, though their trade was recently outlawed. Pangolin scales, which once were discarded, are now sold to wildlife traders in the cities.

were poached from 2000 through 2013—mainly for their scales, used in traditional medicine. Pangolins are believed to be the most heavily trafficked nonhuman mammal in the world.

Law enforcement officers in Zimbabwe know that when they confiscate a pangolin, they should take it to Hywood. She's one of the few people in the world who can keep pangolins alive in captivity. They're sensitive creatures, picky eaters that consume only certain species of ants and termites, a diet that's very difficult to replicate in captive situations.

But by letting them roam for hours a day across the property with stand-in mothers for protection, Tikki Hywood has helped many pangolins, Tamuda and his mother among them, recover well enough to be returned to the wild.

"Every time someone brings us a pangolin, I wonder if it's the last one in Zimbabwe," says Hywood, who founded the rescue center in 1994.

All eight species of pangolins, four in Africa and four in Asia, are in danger of extinction driven by the illegal trade. That's why Tamuda's caregiver isn't being named. He and Hywood worry that if traders know the identities of the caregivers, they might be targeted by criminals who want access to the rescued animals.

Pangolins look like scaly armadillos, but they're more closely related to bears and dogs. They constitute their own taxonomic order, and if they disappear, there'll be nothing like them left on Earth.

International trade in the four species of Asian pangolins has been prohibited since 2000. In 2017 a ban on international commercial trade in all eight species went into effect, voted in place by the 183 governments that are party to the Convention on International Trade in Endangered Species (CITES), the treaty that regulates cross-border trade in wild animals and their parts.

At least 67 countries and territories on six continents have been involved in the pangolin trade, but the shipments with the biggest quantities of scales have originated in Cameroon, Nigeria, Sierra Leone, and Uganda, according to an analysis by Traffic. And they've mainly been heading to China.

"In the last decade, there's been a massive growth in intercontinental trade in pangolins, especially their scales," says Dan Challender, chair of the pangolin specialist group with the International Union for Conservation of Nature (IUCN), the global authority on the status of threatened species. Previously, most pangolin poaching and smuggling occurred within Asia, he says. This shift means that Asian pangolins are becoming difficult to find but that the value of scales makes it worth the extra cost to smuggle pangolins from Africa to Asia.

Pangolins are eaten as bushmeat in western and central Africa and by some indigenous groups in South and Southeast Asia. Their parts also are used in Ghana, Nigeria, South Africa, and elsewhere in sub-Saharan Africa as traditional medicine. And among some people in Vietnam and China, pangolin meat is considered a delicacy. But it's demand for their scales that's wiping out the animals.

Typically dried, ground into powder, and put into pills, pangolin scales are used in a range of traditional Chinese remedies, from treatments to help mothers with lactation to relief for arthritis and rheumatism. Scales can be found in medicine markets throughout Asia, including Vietnam, Thailand, Laos, and Myanmar.

In China, where such treatments continue to be sanctioned by the government, more than 200 pharmaceutical companies produce some 60 types of traditional medicines that contain pangolin scales, according to a 2016 report by the China Biodiversity Conservation and Green Development Foundation. Every year Chinese provinces collectively issue approvals for companies to use an average 29 tons of the scales, which roughly represents 73,000 individual pangolins.

China's pangolins had become noticeably scarce by the mid-1990s, according to some reports, because of overhunting. As demand persisted, Chinese companies continued to make pangolin products, ostensibly by turning to two legal sources of scales: stockpiles amassed from pangolins hunted within China before their

IN CHINA MORE THAN **200 PHARMACEUTICAL COMPANIES** PRODUCE SOME 60 TYPES OF TRADITIONAL MEDICINES THAT CONTAIN **PANGOLIN SCALES.**

numbers crashed and imports brought into the country before the bans went into place.

Pangolin trade records from CITES show that China imported a little more than 16 tons of scales during the 21-year period from 1994 to 2014—not nearly enough to meet the demand from pharmaceutical companies. Furthermore, the provincial governments often don't verify that businesses are getting scales from stockpiled, rather than recently—and illegally—caught pangolins, says Zhou Jinfeng, director of the China Biodiversity Conservation group in Beijing that has been investigating the pangolin trade. He says he's skeptical that scale stockpiles in China are big enough to fill companies' needs more than two decades after pangolins virtually disappeared in the country.

"I don't buy it," he says. "After so many years, they still have that many in the stockpiles?"

NO ONE REALLY KNOWS how many tons of pangolin scales are being smuggled each year—that's the nature of the black market. But we do know it's a lot, and we do know that the biggest shipments are going to China.

In 2017, for example, Chinese customs officials confiscated more than 13 tons of pangolin scales, from as many as 30,000 pangolins—one of the biggest seizures on record. Last year Hong Kong authorities seized 7.8 tons of scales in a single shipment on its way to China.

In all, China accounted for almost 30 percent of scale seizures globally from 2010 to 2015, according to Traffic. Keeping in mind that seizures are believed, conservatively, to represent about a quarter of actual illegal trade, these numbers suggest that hundreds of thousands of pangolins are slaughtered each year. (National Geographic asked several Chinese government agencies for comment and received no response.)

Chinese companies are said to be working to breed pangolins on a large scale so they'll have a steady supply. According to the China Biodiversity Conservation group, the government as of 2016 had issued 10 licenses to facilities to breed pangolins, ranging from rescue centers to investment companies. Another 20 pharmaceutical companies—along with businesses in Uganda, Laos, and Cambodia—launched a "breeding alliance" in 2014.

The problem is that no one has figured out how to breed pangolins on a commercial scale. "There's just no way—you cannot satiate demand through breeding," says Paul Thomson, a conservation biologist and co-founder of the nonprofit Save Pangolins. "Pangolins stress so easily. And they don't rebound quickly."

Most pangolins don't survive more than 200 days in captivity, he says, let alone breed and give birth.

This hasn't stopped Chinese businesspeople from trying. In 2013 a Chinese woman named Ma Jin Ru started a pangolin-breeding operation called Olsen East Africa International Investment Co. Ltd., in Kampala, Uganda, with a provisional permit from the Uganda Wildlife Authority and, later, with backing from a government-affiliated Chinese foundation. Not long after, a company called Asia-Africa Pangolin Breeding Research Centre was also registered and licensed in Kampala.

Both companies were raided, in 2016 and 2017 respectively, by Ugandan authorities who had grown suspicious that the facilities were serving as cover for the trafficking of pangolins caught from the wild. The license issued to Olsen East Africa, for example, permitted captive breeding, but investigators suspected the companies were capturing and trading pangolins illegally—without a permit.

Another Asia-Africa Pangolin Breeding Research Centre was established, in Mozambique, in 2016 and later raised suspicions among Mozambican wildlife authorities for the same reasons. In China, investigators from Zhou's nonprofit tried to visit several of the licensed facilities, all of which denied them access.

Keeping pangolins alive in captivity is a gargantuan task. In addition to their unique diet, they require special care because they're prone to stomach ulcers and pneumonia, usually brought on by stress. Six zoos and a nonprofit in the United States imported 46 pangolins from Togo in 2016, aiming to study the animals under controlled conditions and establish a self-sustaining population. As of early March, 16 had died.

PANGOLINS ARE NOT HARD to find in Cameroon. They're for sale at outdoor bushmeat markets, where they lie dead next to monkeys and pythons on folding tables. They're for sale on the sides of the roads, where vendors hold them upside down by the tails for passing drivers to see. They're a common enough sight

Imperiled Pangolins

Pangolins—scaly, shy, and sensitive—are believed to be the world's most trafficked nonhuman mammals. Their scales, which are made of keratin (the material in fingernails), have no scientifically proven curative properties but are in demand for use in traditional Chinese medicine. All eight species are threatened with extinction, despite a 2017 ban on international commercial trade, and experts estimate that more than a million pangolins were poached from 2000 through 2013.

AFRICAN SPECIES

Temminck's ground pangolin ●○○
Smutsia temminckii

This ground pangolin is the only species that regularly walks on hind legs, using its large tail as a counterbalance. This keeps its front claws sharp for digging.

Black-bellied pangolin ●○○
Phataginus tetradactyla

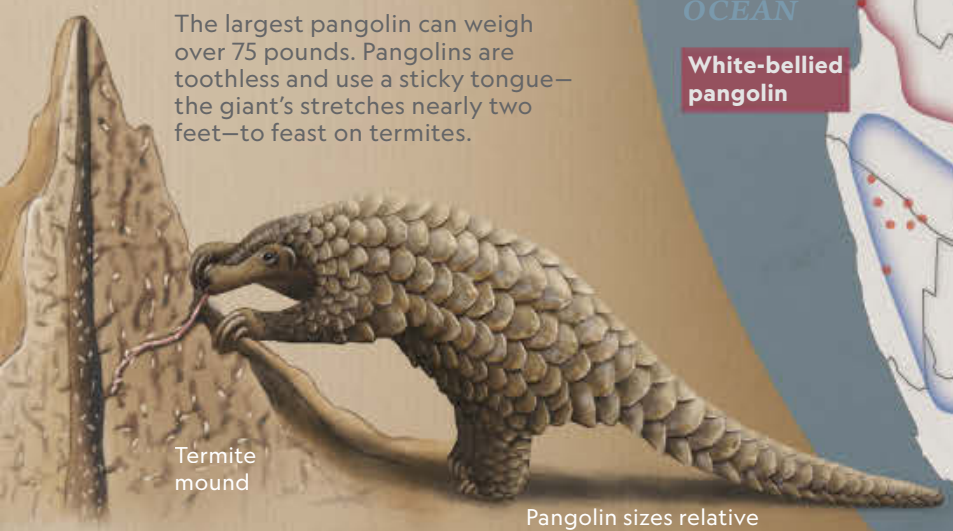
The smallest of the eight species and the only one with black skin, this pangolin has 47 vertebrae in its tail, more than in the tail of any other mammal.

White-bellied pangolin ●○○
Phataginus tricuspis

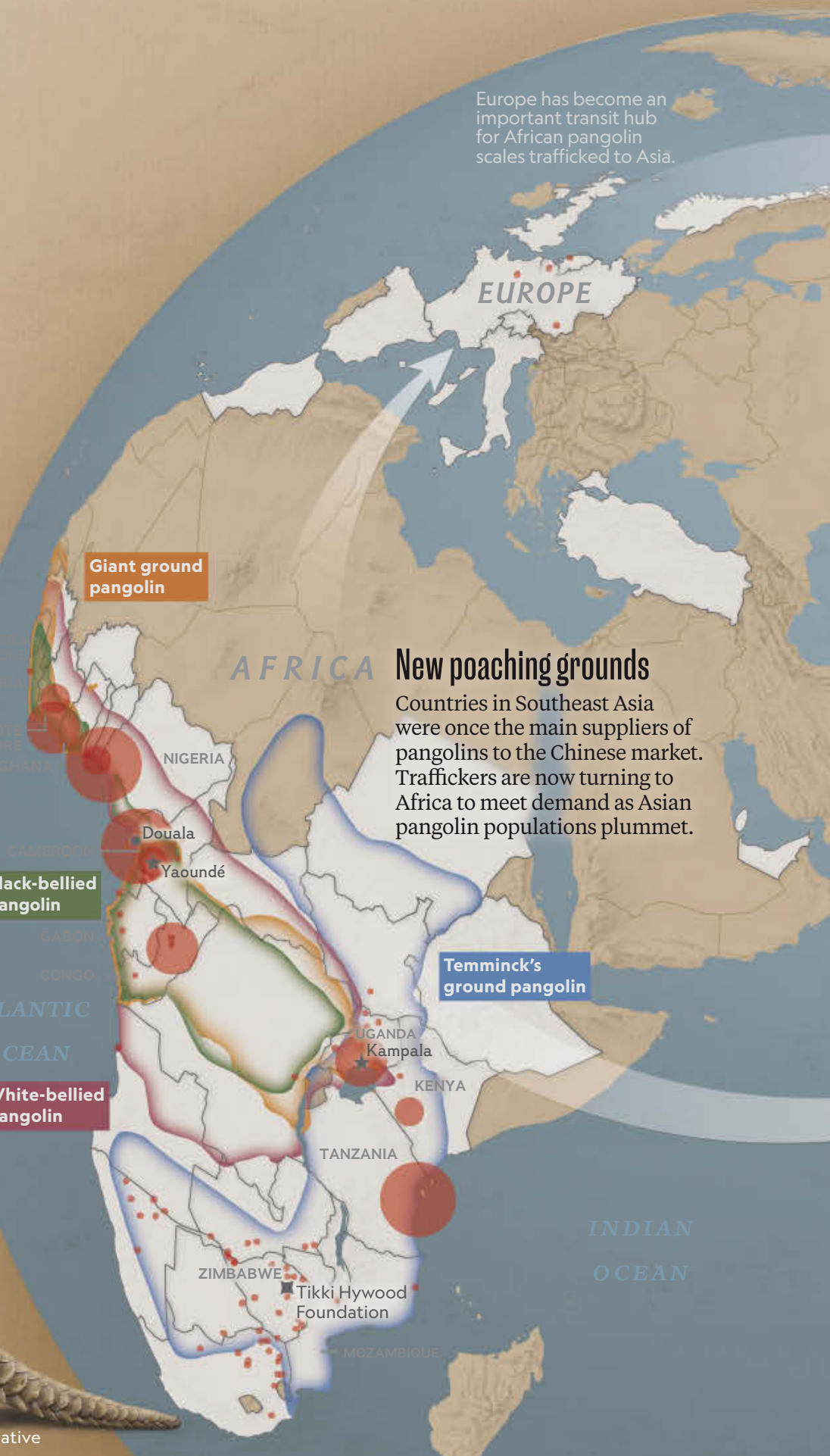
The most common of the tree-dwelling pangolins—and the leading species poached in Africa—lives in tropical forests and dense woodlands.

Giant ground pangolin ●○○
Smutsia gigantea

The largest pangolin can weigh over 75 pounds. Pangolins are toothless and use a sticky tongue—the giant's stretches nearly two feet—to feast on termites.



Pangolin sizes relative to one another



New poaching grounds

Countries in Southeast Asia were once the main suppliers of pangolins to the Chinese market. Traffickers are now turning to Africa to meet demand as Asian pangolin populations plummet.

Pangolin seizures

Estimated number of confiscated pangolins based on reported seizures of bodies, parts, and scales, 2000-2018

- More than 20,000
- 5,000–20,000
- 1,500–4,999
- 500–1,499
- Fewer than 500

Conservation status

- ●○○ Vulnerable
- ●●○ Endangered
- ●●● Critically endangered

Pangolin traffickers

- Main countries involved in trafficking
- Major trade flow

Trying to stop a deadly market

Law enforcement agencies made 1,500 seizures representing an estimated 700,000 pangolins between 2000 and 2018. Most of the trade, however, goes undetected and unreported.

China's questionable sources

Pharmaceutical companies in China have been allowed to obtain some 29 tons of pangolin scales each year. Companies reportedly use scales from the same decades-old stockpiles, but the origins of the scales aren't carefully tracked.

Illegal pangolin products are shipped from Asia to the United States.

Record breakers: In 2019 Singapore seized a shipment of 14.2 tons of scales—representing an estimated 36,000 pangolins—from Nigeria bound for Vietnam. In 2017 China intercepted a shipment from Africa of 13 tons of scales (about 30,000 pangolins).

ARCTIC OCEAN
ASIA
Indian pangolin
PAKISTAN
CHINA
Chinese pangolin
NEPAL
INDIA
PACIFIC OCEAN
MYANMAR
Shenzhen
Hong Kong
LAOS
VIETNAM
PHILIPPINES
THAILAND
Philippine pangolin
MALAYSIA
INDONESIA
Surabaya
Sunda pangolin

ASIAN SPECIES

Chinese pangolin ●●●
Manis pentadactyla

The only pangolin that hibernates in winter has been poached so heavily that by the mid-1990s it had come close to extinction in China.

Indian pangolin ●●○
Manis crassicaudata

The largest Asian species ranges as far west as Pakistan. As with other pangolins, babies less than six months old ride on their mothers' backs.

Sunda pangolin ●●●
Manis javanica

This ground and tree species is believed to be the most trafficked pangolin today. Scales help protect pangolins from bites when they feed on ants.

Philippine pangolin ●●○
Manis culionensis

This arboreal pangolin is endemic to Palawan and nearby Philippine islands. Hunters sometimes use dogs to track these and other pangolins.

CLARE TRAINOR, TAYLOR MAGGIACOMO, AND KAYA BERNE, NGM STAFF. SOURCES: DAN CHALLENDER, IUCN SSC PANGOLIN SPECIALIST GROUP; ENVIRONMENTAL INVESTIGATION AGENCY; IUCN RED LIST; SARAH HEINRICH, UNIVERSITY OF ADELAIDE; SCOTT TRAGESER, CREATIVE CONSERVATION ALLIANCE; KATIE SCHULER, CORAL & OAK STUDIOS

A hunter from a village in Indonesia says he delivers pangolins to the city of Surabaya on a weekly basis. Pangolins are protected by national laws in the countries where they're found, and international commercial trade in them is banned. Even so, poaching and trafficking are major threats to pangolins' survival.

for you to think: None of these people seem to be having trouble finding pangolins, so how close to extinction can they be?

The answer is that we don't have much of an idea how many there are in the first place. Nocturnal, solitary, and shy, they're difficult to count. But it's clear from data compiled by Traffic and other nongovernmental organizations that they're being consumed in and exported from Cameroon and elsewhere in western and central Africa in alarming numbers.

When photographer Brent Stirton and I went to Cameroon last summer, we called up Angelia Young. A South African living in Yaoundé, the capital, with her husband and their three kids, she was arranging to open Cameroon's first pangolin rescue center. Young took us to a restaurant in the Bastos neighborhood, home to embassies and expats. She handed us menus. Listed above the couscous, plantains, and green beans were porcupine, antelope, and pangolin.

This was an ordinary menu for any restaurant in the city, Young said. Bushmeat is popular in Cameroon, where many prefer it to meat from domestic livestock. Earlier, when we'd visited a market in a rural town where a young woman was preparing a pangolin dish to sell, I'd asked her why she cooks it.

"Why not?" she'd said. "It's good."

We didn't order pangolin (it's illegal to hunt, sell, or buy pangolins in Cameroon), but we were curious to see whether the restaurant had it on hand. The cook was happy to oblige, bringing out a platter of small gray frozen bodies on a tray. Playing the curious tourists, we gawked and took snapshots.

Young took us back to her house, which, like all the other homes on her street, was surrounded by a tall, thick wall for security. As we pulled up, I saw a boy in a school uniform, Young's son Nathan, walking what appeared to be a dog. He was pointing his flashlight at the space between the curb and the neighbor's wall, keeping an eye on his pet.

When we got closer, I realized that it wasn't a pooch but a pangolin. The little creature was sniffing and snuffling and scratching the dirt, looking for ants. A pangolin walker, who was supervising the outing, followed close behind, keeping watch over both the animal and the boy. This pangolin was one of a few Young had rescued and was nursing back to health in her house.

"I'm always saving things. Cats, dogs, birds, whatever. I ended up saving four pangolins and not knowing how to take care of them," she said of her first rescue, in late 2016. "The only person I got to answer the phone was Lisa in Zimbabwe."

Hywood began sending Young pangolin care packages of medicine and blankets, along with health guidelines for the animals. Their conversations eventually led to the inception of the rehabilitation center Young was preparing to launch—Tikki Hywood Foundation Cameroon.

Young introduced us to eight-year-old Nathan and told him we were going to take a walk to the grocery store around the corner to buy some

In Vietnam a sixth-generation traditional medicine practitioner demonstrates how he prepares herbs to mix with the dried pangolin scales his wife is grinding. Scales are believed to be helpful for a range of maladies, but there's no scientific support for these claims.

scallions. We left the pangolin under the walker's watchful eye, and on the way Nathan talked about how much he loves pangolins and how excited he is to help them. He was clearly proud of his mom.

Next to the outdoor produce stand, a group of Chinese men and women were eating dinner. They greeted us in French, with big smiles. As we began picking over the leafy greens, Young made a small gesture with her chin to the left. Near the side door to the building, behind a low wooden fence, was a chest freezer. On top were several dozen pangolin scales, laid out to dry. Young and Nathan bought some scallions and other vegetables while I milled around to get a better look at the scales, which wasn't hard: They weren't hidden.

"Of course it's shocking to see—it's in your face," Young said later. "But for them, it's nothing. You'll see it everywhere."

A MAJOR STASH of pangolin scales would be smuggled into Cameroon soon, investigators with the Last Great Ape Organization, an NGO, told us during our visit. The group, which helps governments with wildlife law enforcement, had been tracking these smugglers for more than a year and knew that investigators would have a chance to break up this supply chain when the men drove into the port city of Douala with their haul.

A pangolin peeks from a box on the way up a remote mountain in Vietnam, where 25 pangolins rescued from the illegal trade will be released back into the wild. Based in Cuc Phuong National Park, the nonprofit Save Vietnam's Wildlife helped train the country's first anti-poaching team and has rescued more than a thousand pangolins.

Save Vietnam's Wildlife is caring for this youngster until it's strong enough to be released. Although demand for pangolin meat and scales exists in Vietnam, many pangolins rescued there were destined for China, where pharmaceutical companies sell commercial traditional medicines containing scales. Experts say practitioners and buyers must be taught about alternatives in the Chinese medicine pharmacopoeia to reduce demand for these disappearing animals.

Sure enough, right after I left the country, police and wildlife officials intercepted the shipment and arrested six people. The pangolin scales had arrived by truck from the Central African Republic, where it's likely that traffickers had amassed them from many smaller-scale traders there, as well as from traders in Cameroon and the Democratic Republic of the Congo. The plan, said Eric Kaba Tah, of Last Great Ape, was to drive the shipment to Douala, where the smugglers would sell it up a level on the supply chain. Often, the next destination for the scales would be Nigeria, Tah said, then on to China, Malaysia, or Vietnam.

"More and more we are seeing wildlife products leave the central African subregion, passing through Cameroon to Nigeria, where traffickers believe wildlife law enforcement is not as strong," Tah said.

It helps traffickers that Africa-to-Asia smuggling routes already exist for other wildlife products. Shipments of pangolin scales have been discovered alongside ivory, hippo teeth, and other illicit animal parts.

The organized criminal networks that move ivory also move pangolin scales, according to the Center for Advanced Defense Studies, a Washington, D.C.-based research group that focuses on illicit networks, including organized wildlife crime. Such crimes are typically associated with money laundering, tax fraud, illegal arms possession, and other offenses.

CHINA IS THE BIGGEST consumer of pangolin scales, but it doesn't have to be that way, says Steve Given, the former associate dean of the American College of Traditional Chinese Medicine, in San Francisco. He has identified at least 125 herbal, mineral, and animal alternatives in the Chinese medicine pharmacopoeia, depending on what a patient needs to treat. "There's virtually no reason that anyone needs to use *chuan shan jia* clinically," he said, referring to pangolin scales by a traditional name.

Western medicine so far has found no evidence that pangolin scales, which consist of keratin, the same material that makes up fingernails, hair, and rhino horn, have any physiological effects on humans. But traditional medicine texts hold that the scales can be effective at treating imbalances in the body, such as "blood stasis," a condition that can bring on a stabbing or severe pain and may be associated with menstrual disorders, trouble with lactation, and arthritis.

As long as millions of people turn to traditional medicine for relief—and that number is likely to increase because traditional Chinese medicine is set to become an official part of the World Health Organization's medical compendium—educating health care providers and patients about alternatives will be an important way to protect pangolins from extinction, Given says.

Back in Cameroon, Young said she was planning to release three pangolins into the wild and invited Stirton and me to come along. Two of the pangolins had been found in a garage, and one surrendered by a woman who received it as a gift. As we bumped along an unpaved road, I thought about the pangolins curled in boxes in the back of the car. They were getting quite a ride. The roads were too washed out to go to the regular release site, so we stopped at an open field instead.

As we walked a few yards into the field, Young warned us to watch out for the biting flies that transmit a parasite that can grow into a worm in your eye. While I worried about that, she set the first pangolin on the ground. It walked into the tall grass and disappeared. We saw the tops of the grass blades rustle a bit—and that was that. Within 15 minutes, the other two pangolins also had been set free. It felt anticlimactic to say the least.

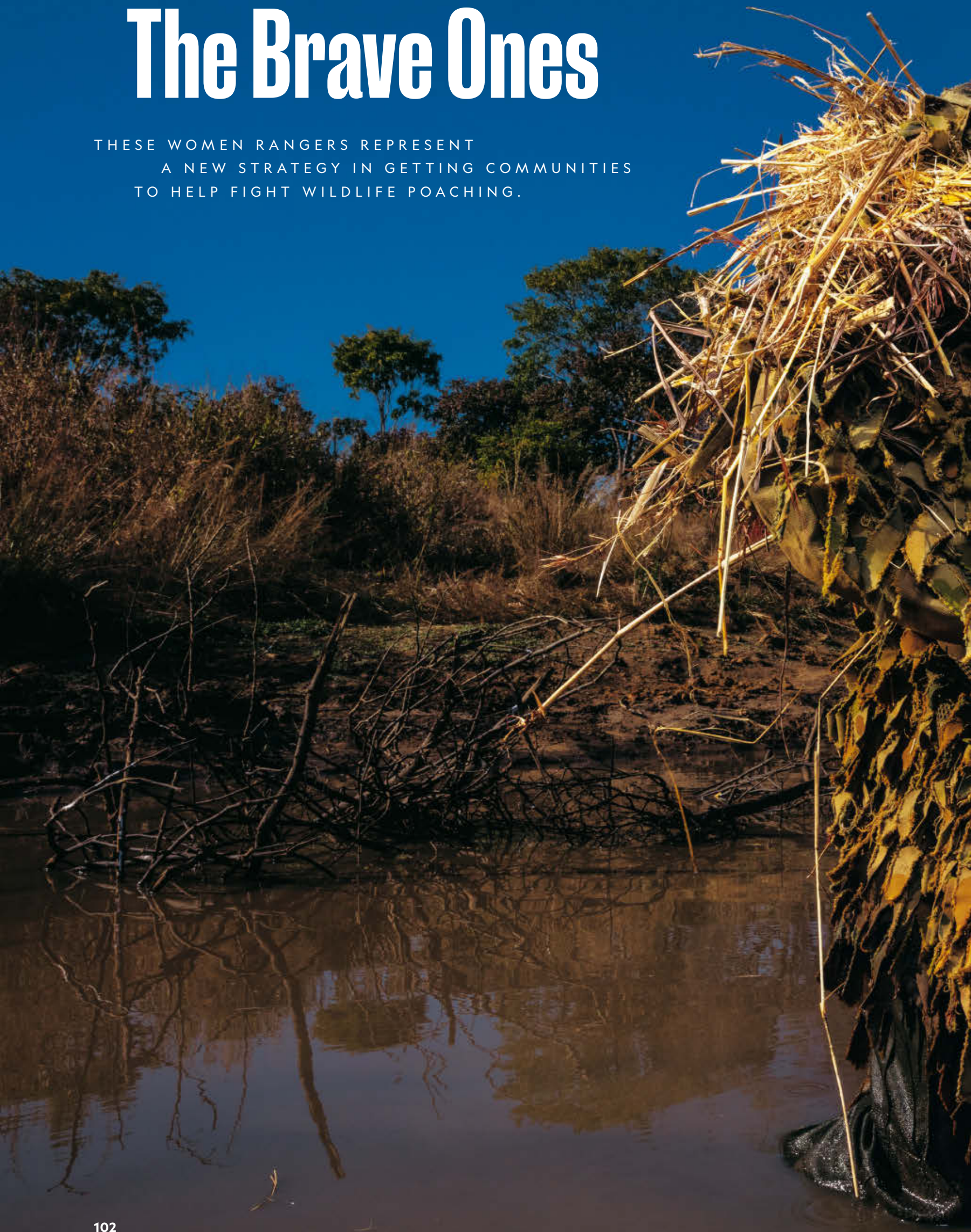
On the return drive, I asked Young about a bushmeat market we'd passed on the way out. It had porcupines for sale, and there were a handful of pangolin scales drying nearby. Wasn't it likely that the pangolins she'd just released would soon be hunted too?

Yes, she said, it's very possible. "It's bittersweet, letting them go. There's no security." Nonetheless, she added, it's a second chance. Maybe they'll reproduce before they're caught again, contributing a few more pangolin babies to the ever dwindling population. Every pangolin counts, she said. ▯

Senior Editor **Rachael Bale**'s story on trafficking of helmeted hornbills appeared in September 2018. **Brent Stirton** was named the 2017 Wildlife Photographer of the Year for his 2016 rhino coverage.

The Brave Ones

THESE WOMEN RANGERS REPRESENT A NEW STRATEGY IN GETTING COMMUNITIES TO HELP FIGHT WILDLIFE POACHING.



BY **LINDSAY N. SMITH**

PHOTOGRAPHS BY **BRENT STIRTON**

Petronella Chigumbura, a member of the Akashinga—a nonprofit, all-female anti-poaching unit—practices reconnaissance techniques in the Zimbabwean bush.

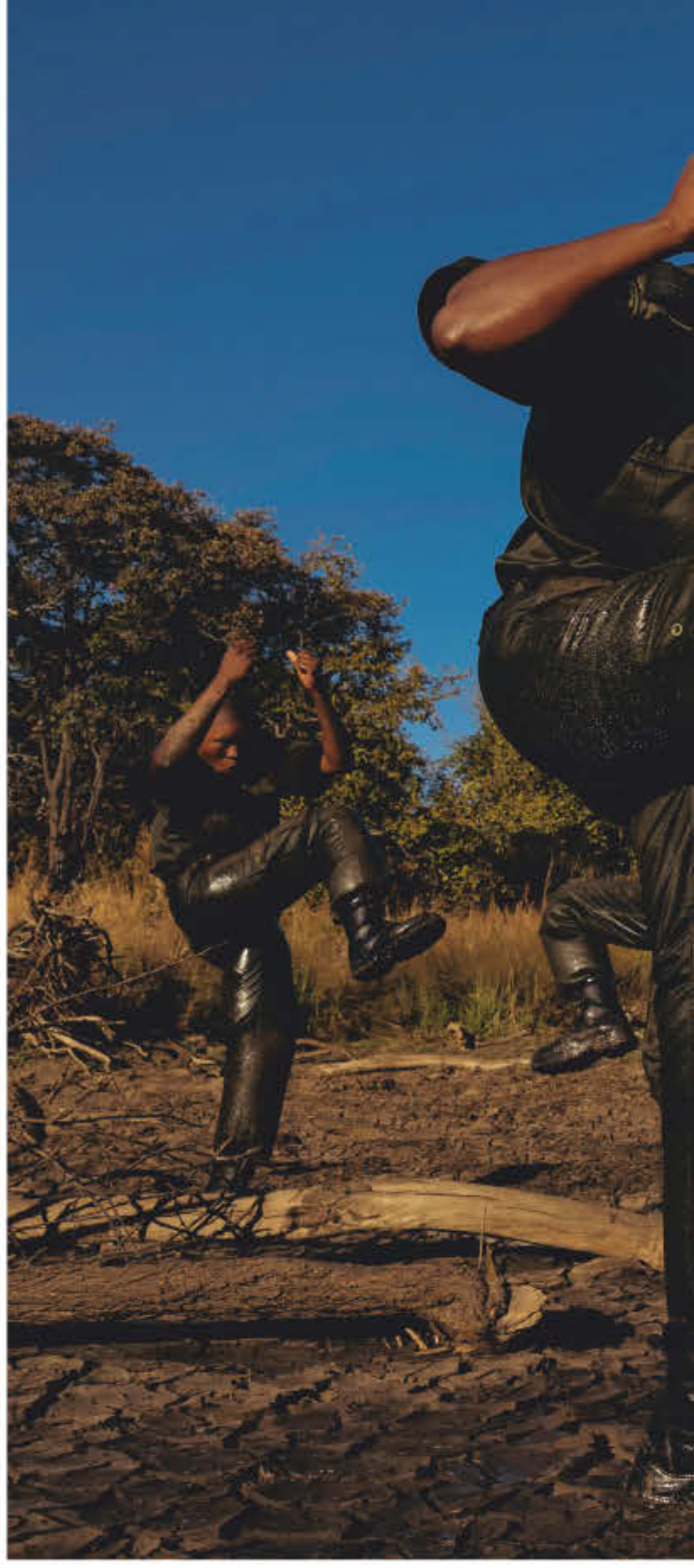
The rangers train with rifles, though some conservationists argue that arming the women increases the threat of violence. Akashinga founder Damien Mander disagrees. “With the women, [the rifle] is more of a tool. With the men, it’s more of a toy,” he says.

Rangers train in the mud near their base in northeastern Zimbabwe. In the bush, the women must be prepared to face heavily armed poachers. But there are no Rambos in this work: Functioning as a disciplined unit is essential, Mander says. “One in, all in.”

Sgt. Vimbai Kumire holds up a photo of a dead leopard on her phone.

She stares at the image as the truck she's riding in bounces over the rutted road. The cat's neck is slashed and its bloody paws hang slack. "Before this job, I didn't think about the animals," she says.

Now Kumire, 33, and her all-female wildlife ranger team, the Akashinga, are among the animals' fiercest protectors. The rangers are an arm of the nonprofit International Anti-Poaching Foundation, which manages Zimbabwe's Phundundu Wildlife Area, a 115-square-mile former trophy hunting tract in the Zambezi Valley ecosystem. The greater region has lost thousands of



Mander, a former Australian special forces soldier who has trained game rangers in Africa for more than a decade, leads the women through hand-to-hand combat exercises. After years of training male rangers, Mander concluded that women are often better suited for the job. He says they're more adept at de-escalating violent situations and less susceptible to bribery.

The nonprofit National Geographic Society helped fund this story. To read more reporting about wildlife crime, visit *natgeo.com/wildlife-watch*.

KATIE ARMSTRONG, NGM STAFF
SOURCE: INTERNATIONAL ANTI-POACHING FOUNDATION

elephants to poachers over the last two decades. The Akashinga ("brave ones" in the Shona language) patrol Phundundu, which borders 29 communities. The proximity of people and animals sometimes leads to conflicts such as the one Kumire's headed to now, involving the leopard.

At the scene, Kumire wades into an angry crowd. Standing five feet two inches tall, she could easily get lost in the chaos, but she moves calmly and confidently through the emotionally charged group, speaking softly but firmly. Ten injured men slowly come forward. One has a bandage on his cheek, another's arm is wrapped in blood-stained cotton. Eight others nursing scratches and punctures cluster around her.

Conservation officials had collected the leopard's carcass and accused the men of wrongdoing, inflaming the crowd. The injured men say the leopard attacked, but based on their minor wounds, the rangers are skeptical this was unprovoked self-defense. Killing wildlife without a permit is a criminal offense. But the leopard's skin, teeth, claws, and bones—worth hundreds of dollars on the black market—represent a month's salary in Zimbabwe's impoverished economy.

With the carcass secured and the events surrounding the leopard's death duly recorded, the team's job now is to remind the community they're here to help with wildlife-human interactions. The women load the wounded men into their truck and take them to the local clinic.

Scenes like this are the essence of the Akashinga's mission and familiar scenarios for its founder, Damien Mander, a tattoo-covered Australian and

The Akashinga's training includes exercises to promote teamwork and increase strength. Here the rangers carry a tree trunk as part of their regimen. The anti-poaching team is made up of women from villages surrounding the Phundundu Wildlife Area.

LEFT

Wadzanai Munemo and another ranger encounter an elephant while patrolling conservation land that once was part of a trophy hunting area. At the start of their efforts, the rangers saw animals as little as once a week. Now they spot them daily.

RIGHT

Primrose Mazuru plays with her daughter while on a visit home. Like many Akashinga, Mazuru was in an abusive relationship before becoming a ranger. Along with other rangers, she now receives counseling on topics such as self-esteem.

former special forces soldier who has trained game rangers in Zimbabwe for more than a decade. His experiences serving in Iraq and on the front lines of Africa's poaching war have taught him that change—be it peace among humans or attitudes about wildlife—can't happen without buy-in from the community. "Local people have a vested interest in where they come from, where they live," he says. "Foreigners don't."

With that local-first mentality, Mander turned to Phundundu's surrounding villages—specifically their women—to fill the ranks of the Akashinga. After years of training male rangers, he concluded that in some ways women were better suited for the job. He found they were less susceptible to bribery from poachers and more adept at de-escalating potentially violent situations. He also knew that research shows working women in developing countries invest 90 percent of their income in their families, compared with 35 percent for men. In this regard, the rangers demonstrate a key conservation principle: Wildlife is worth more to the community alive than it is dead at the hands of poachers.

Mander sought women who had suffered trauma: AIDS orphans, victims of sexual assault or domestic abuse. Kumire joined after her husband abandoned her and their two daughters. Who better to task with protecting exploited animals, Mander reasoned, than women who had suffered from exploitation? He modeled his selection course on special forces training, subjecting the women to three days of nonstop exercises designed to test their teamwork skills while being wet, cold, hungry, and tired. Of 37 recruits who started the course, 16 were chosen for the training

program; only three quit. Years ago Mander ran a similar course for 189 men. At the end of day one, all but three had quit. "We thought we were putting [the women] through hell," Mander says. "But it turns out, they've already been through it."

THE NEXT MORNING the sun rises over the Akashinga camp—a dozen green tents arrayed on a hilltop that offers a panoramic view of the region. The women eat breakfast, and Mander briefs them on the coming night's two raids—one on the compound of a man said to possess an unlicensed rifle used to kill wildlife, the other on the home of a suspected poacher said to be trying to sell a leopard skin.

They spend the morning practicing, ensuring each ranger knows her position. Then Mander gets behind the wheel, four rangers jump in the back with a local police officer, who will oversee the raid, and the team sets off.

It's after midnight when they finally approach the home of the suspected owner of the unlicensed rifle. Mander speeds into the compound and slams on the brakes. The rangers leap out and take up the positions they had practiced. One raps on the front door. Eventually the suspect allows them inside, where they find the dried skins of several duikers, a small antelope species. The man is handcuffed and loaded into the truck.

It's a clear, black night, and the Milky Way stretches across the sky. The rangers have been up for nearly 24 hours. But the leopard skin seller remains at large. "We are not tired," Kumire says. "We don't tire until our job is done."

Before they return to their base the next morning, they'll arrest the alleged leopard poacher. The next night, they'll catch a suspected elephant poacher. In the hours between, they'll continue their patrols, removing several poachers' snares. It's results like this that show Mander his instinct was right. "Women like this can change everything." ▯

Lindsay N. Smith is on the staff of *National Geographic*. **Brent Stirton** has photographed several wildlife investigative stories, including the illegal ivory trade article for the September 2015 issue.

After searching a house and finding a leopard skin, two rangers question a suspected poacher (standing) while an Akashinga instructor (left) records the interaction. A curious neighbor sits nearby, watching the encounter. It was the suspect's first offense, and he later paid a $300 fine—roughly a month's salary.

Rangers visit a local hangout near the Phundundu Wildlife Area. Since becoming a team, the women have formed strong bonds. “We are one family,” says Chigumbura. “If I face a problem, before I tell my brother or my sister, I tell my [fellow ranger].”

WHO BETTER TO PROTECT EXPLOITED WILDLIFE THAN WOMEN WHO'D SUFFERED EXPLOITATION THEMSELVES?

The rangers gather for a meal at camp. The entire team follows a vegan diet, a rule set by Mander to avoid animal cruelty and support sustainable food choices. "Food is an important part of the program," he says. When Akashinga was formed, Mander enlisted the help of Nicola Kagoro—known as Chef Cola (center-right, with glasses)—to create nutritional, calorie-rich meals that were plant based. "My job is to make sure they have enough energy to do their job in the field," she says.

THE PACIFIC'S

Deep within the Earth, rocky plates compress and pull apart,

WITHIN THE ROCKY BASIN of the Pacific, volcanoes and earthquakes have been causing death and destruction for millennia. The tectonic cycle unleashes enormous energy here, in seismic and volcanic events that change the face of the globe. Today, with booming growth in Asia and parts of the Americas, more people live close to calamity than ever before. On just one island in Indonesia—Java, shown here—41 active volcanoes threaten some 151 million people. As Earth's population swells toward eight billion, the threats from this Ring of Fire will compound.

SCALE VARIES IN THIS PERSPECTIVE.
THE DISTANCE BETWEEN JAKARTA AND SURABAYA IS 410 MILES.
ART: ANTOINE COLLIGNON

FIERY RING

triggering huge quakes and eruptions—and threatening millions.

BY **MANUEL CANALES** AND **MATTHEW W. CHWASTYK**

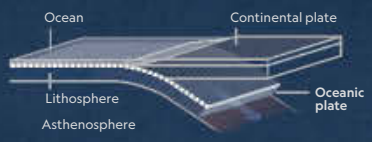
VOLCANIC TITANS

The volcanoes shown are among those most likely to threaten humans. (At press time, an eruption of Popocatépetl raised the alert level to one below mandatory evacuation.) The latest eruption and the number of people living within 60 miles are noted. Each mountain is scaled to show prominence—how far it rises above its immediate surroundings.

ACTS OF SUBDUCTION

Tectonic plates under the Pacific move faster than any others on Earth, driven by a force called slab pull. The larger the slab of lithosphere sinking at a subduction zone, the faster the plate moves, and the stronger the seismic activity.

Plates meet
Cold, dense oceanic lithosphere sinks below an adjacent, lighter plate, plunging into the hot asthenosphere.



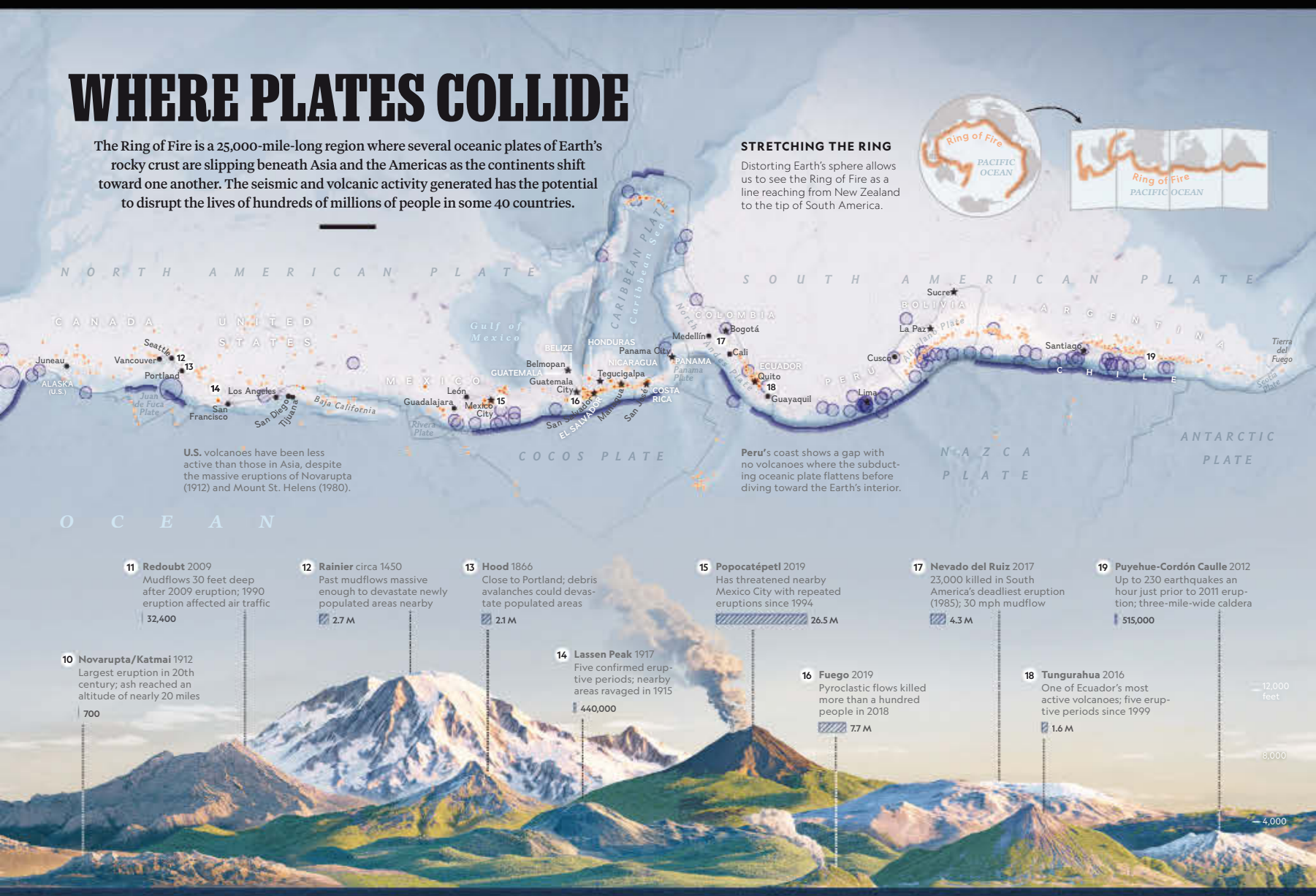
Magma forms
The sinking oceanic plate releases water, lowering the asthenosphere's melting point and creating magma.

WHERE PLATES COLLIDE

The Ring of Fire is a 25,000-mile-long region where several oceanic plates of Earth's rocky crust are slipping beneath Asia and the Americas as the continents shift toward one another. The seismic and volcanic activity generated has the potential to disrupt the lives of hundreds of millions of people in some 40 countries.

STRETCHING THE RING

Distorting Earth's sphere allows us to see the Ring of Fire as a line reaching from New Zealand to the tip of South America.

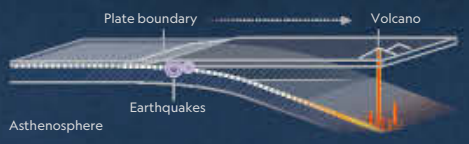


U.S. volcanoes have been less active than those in Asia, despite the massive eruptions of Novarupta (1912) and Mount St. Helens (1980).

Peru's coast shows a gap with no volcanoes where the subducting oceanic plate flattens before diving toward the Earth's interior.

SHALLOW DIVE

The subduction angle can affect where earthquakes and volcanoes arise: Shallower angles may increase their distance from the juncture of tectonic plates.



EARTHQUAKES TRIGGERED

Converging plates at the interface between subducting and overriding lithosphere layers create a seismogenic zone capable of generating the world's most powerful earthquakes.

MANUEL CANALES AND MATTHEW W. CHWASTYK, NGM STAFF; SEAN MCNAUGHTON, VOLCANO ART; TOMÁS MÜLLER, MAP PROJECTION AND RENDERING; CHARLES PREPPERNAU
SOURCES: ADAM SOULE, WOODS HOLE OCEANOGRAPHIC INSTITUTION; ERIK KLEMETTI, DENISON UNIVERSITY; JANINE KRIPPNER, SMITHSONIAN INSTITUTION'S GLOBAL VOLCANISM PROGRAM; W.P. SCHELLART, VRIJE UNIVERSITEIT AMSTERDAM; GEOLOGICAL SOCIETY OF AMERICA; UN OFFICE FOR DISASTER RISK REDUCTION; USGS

DRIFTING PLANTS KNOWN AS SARGASSUM SUPPORT A COMPLEX AND AMAZING VARIETY OF MARINE LIFE.

BY **JAMES PROSEK**

PHOTOGRAPHS BY **DAVID DOUBILET**
AND **DAVID LIITTSCHWAGER**

The Weed That Feeds the North Atlantic

Hatchling sea turtles, like this juvenile loggerhead, make their way from the sandy beaches where they were born toward mats of sargassum weed, finding food and refuge from predators during their first years of life.

PREVIOUS PHOTO

A clump of sargassum weed the size of a soccer ball drifts near Bermuda in the slow swirl of the Sargasso Sea, part of the North Atlantic gyre. A weed mass this small may shelter thousands of organisms, from larval fish to seahorses.

DAVID DOUBILET (BOTH)

‘There’s nothing like it in any other ocean,’ says marine biologist Brian Lapointe. ‘There’s nowhere else on our blue planet that supports such diversity in the middle of the ocean—and it’s because of the weed.’

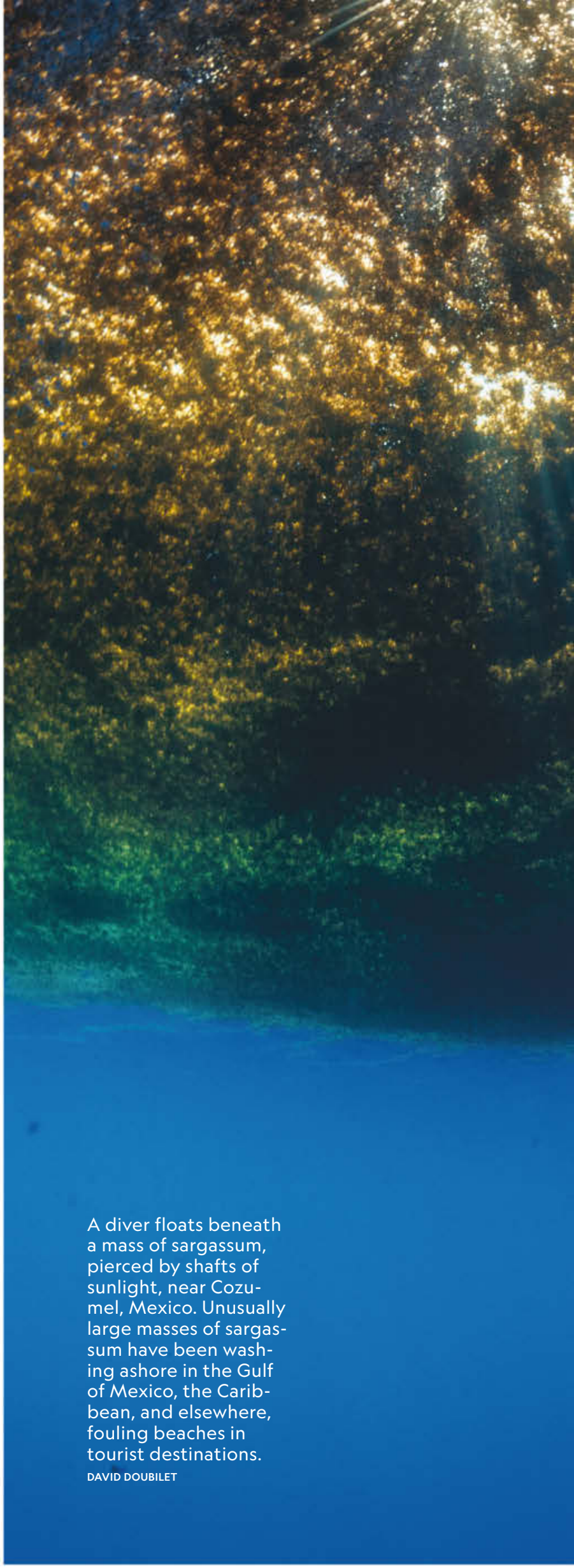
LAPOINTE IS TALKING about a floating seaweed known as sargassum in a region of the Atlantic called the Sargasso Sea. The boundaries of this sea are vague, defined not by landmasses but by five major currents that swirl in a clockwise embrace around Bermuda. Far from any mainland, its waters are nutrient poor and therefore exceptionally clear and stunningly blue.

The Sargasso Sea, part of the vast whirlpool known as the North Atlantic gyre, often has been described as an oceanic desert—and it would appear to be, if it weren’t for the floating mats of sargassum.

The seaweed may seem unremarkable at first glance—just bunches of drifting plant matter—but as Lapointe has helped illuminate through his work, sargassum is the basis of a complex ecosystem that nurtures a stunning array of marine life. It serves as a mobile shelter and a movable feast.

For 36 years Lapointe, a biologist with Florida Atlantic University’s Harbor Branch Oceanographic Institute in Fort Pierce, has combed the Sargasso Sea, observing sargassum by satellite and experiencing it firsthand in scuba gear. He wanted to figure out where the weed comes

The nonprofit National Geographic Society, working to conserve Earth’s resources, helped fund this article.



A diver floats beneath a mass of sargassum, pierced by shafts of sunlight, near Cozumel, Mexico. Unusually large masses of sargassum have been washing ashore in the Gulf of Mexico, the Caribbean, and elsewhere, fouling beaches in tourist destinations.
DAVID DOUBILET

from, how it moves, what it sustains, and what sustains it—and to unravel the complex relationship sargassum has with other forms of marine life, from seahorses to great white sharks. Only by learning about this vital resource, he says, can we protect it from potential threats, such as ocean acidification and pollution.

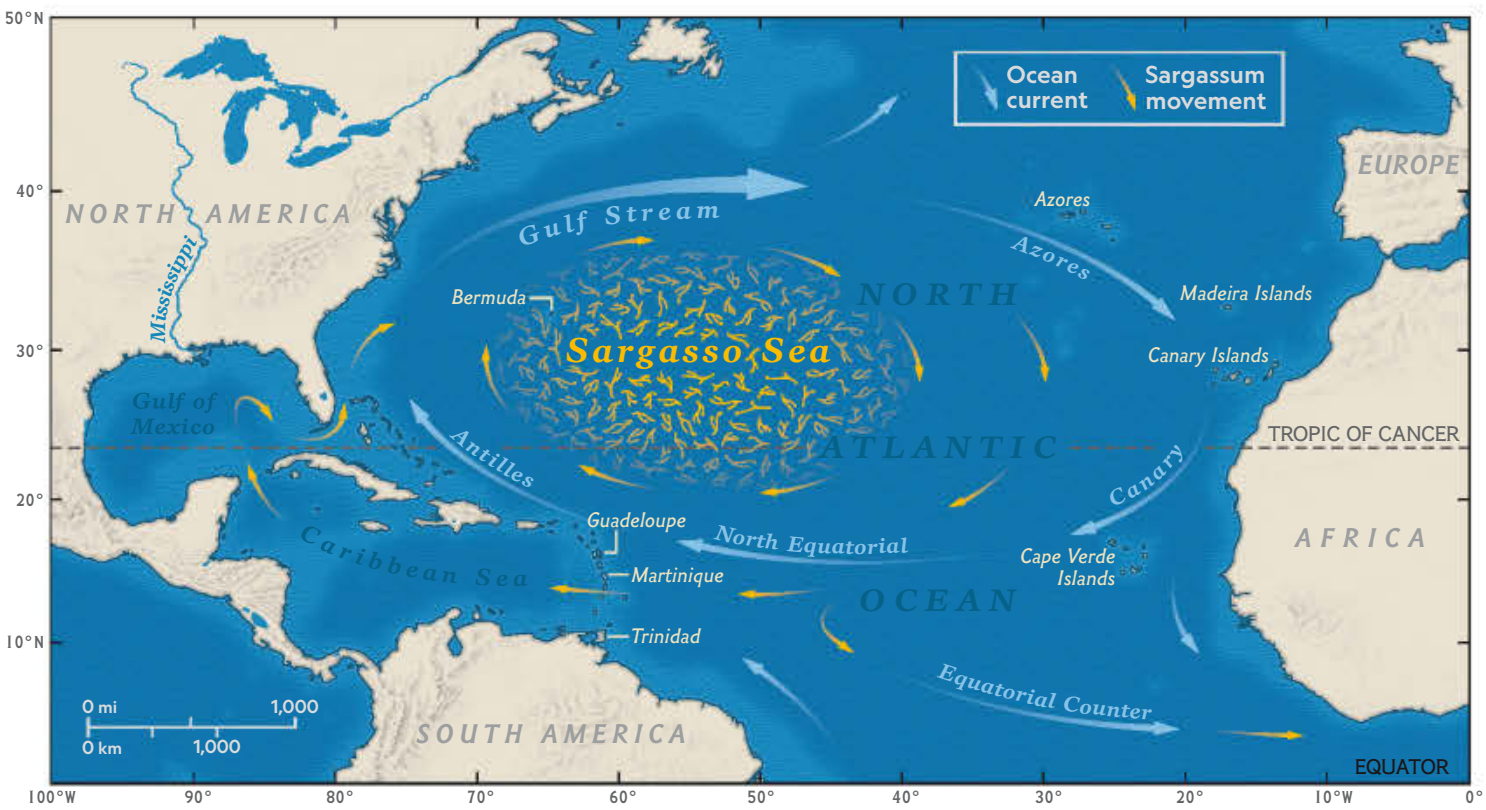
When it needs protecting, that is.

During the past few years, sargassum has been making the news not as life-giving manna but as a scourge, mounds of it fouling beaches in the Caribbean and Mexico. No one's talking about protecting sargassum anymore, Lapointe says. "It's more like, how do we get it to go away?"

The sailors aboard Christopher Columbus's *Santa María* were of like mind. The weed in some places was "so thick that it actually held back the ships," reads a September 20, 1492, entry in the ship's log. Early explorers noted that the air bladders keeping the seaweed afloat reminded them of a grape they called *sargazo*.

Sargassum originates in nutrient-rich zones close to the coast of the Americas, particularly in the Gulf of Mexico. Currents carry it around the Florida Peninsula, where it's taken up by the northward-flowing Gulf Stream and eventually ends up in the Sargasso Sea.

Oceanographer Sylvia Earle, who helped initiate an effort to make the Sargasso Sea the first high seas marine protected area, likens sargassum to a golden rainforest (see her essay, page 140). It's an apt metaphor, because the weed forms a kind of canopy at the ocean surface.



RILEY D. CHAMPINE, NGM STAFF
SOURCE: BRIAN LAPOINTE, FLORIDA ATLANTIC UNIVERSITY

Small gas-filled bulbs called pneumatocysts keep sargassum buoyant and close to the surface, providing a raft for this sargassum shrimp, whose color resembles the weed that hosts it.
DAVID LIITTSCHWAGER

Sargassum brings to my mind a floating reef or even a marine grassland—a Serengeti of the sea.

Its tangled tresses support an astonishing diversity of organisms that hide in and feed off the weed—the larvae and juveniles, according to one study, of 122 different species of fish, as well as hatchling sea turtles, nudibranchs, seahorses, crabs, shrimps, and snails. The seaweed in turn is nourished by the excrement of these organisms.

Larger creatures such as fish and turtles find plenty to eat amid the sargassum, and they attract bigger predators—triggerfish, triple-tails, filefish, mahi-mahis, and jacks, on up the chain of life to sharks, tuna, wahoos, and billfish. Tropic birds, shearwaters, petrels, terns, boobies, and other birds of the open ocean roost and forage on sargassum mats.

The two predominant species of sargassum in the Sargasso Sea are the only seaweeds in the world that don't begin life attached to the seafloor. As a consequence of this life unmoored, the translucent gold- to amber-colored mats exist at the whim of the winds and currents, pulled apart in storms and reassembling in calmer seas, their edges locking together like Velcro. The weed masses vary in size from several miles long to pieces no bigger than your hand.

"Even those little clumps have organisms associated with them," says Jim Franks, a senior research scientist and sargassum expert with the University of Southern Mississippi's Gulf Coast Research Laboratory in Ocean Springs. The teeming life associated with sargassum must constantly adjust to the coming together and breaking apart of the nurturing islands.

A sargassum menagerie

David Liittschwager photographed an abundance of animals in sargassum from the Gulf of Mexico and off Bermuda. Here's a sampling.

1. *Sargassum fish*
2. *Common octopus*
3. *Glasseye snapper*
4. *Copepod*
5. *Sergeant major*
6. *Balloonfish*
7. *Sargassum nudibranch*
8. *Squirrelfish, juvenile*
9. *Yellowtail damselfish*
10. *Dolphinfish, juvenile*
11. *Balloonfish, juvenile*
12. *Mahi-mahi*
13. *Bearded flying fish*
14. *Shore crab*

DAVID LIITTSCHWAGER
(MAGNIFICATION VARIES)

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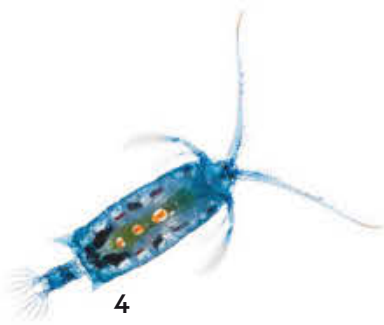

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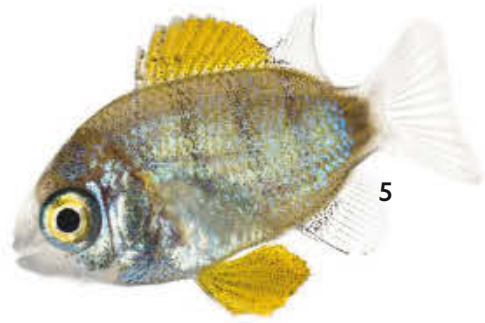

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13

14

A sperm whale swims beneath golden sargassum. The weed nurtures countless life-forms, from single-celled organisms to the largest mammals. Excrement from these creatures helps extend the weed's life.

BRIAN SKERRY

Sargassum enmeshed in rope provides shade and shelter for triggerfish. Human-made debris, from shipping pallets to plastic crates and fuel canisters, can provide a drifting platform on which life can grow, but plastic is especially harmful to many species.
DAVID DOUBILET

Sargassum, Franks says, "is one of the most dynamic marine habitats imaginable."

THE SARGASSO SEA has long been associated with mystery. Eighteenth-century sailors referred to this part of the Atlantic as the horse latitudes because, the story goes, ships would get becalmed there and have to dump their horses overboard as freshwater supplies dwindled. And the Sargasso overlaps with the mythic region known as the Bermuda Triangle, where ships and planes are said to have disappeared without a trace. Whether or not you buy into the legends, when you're out on the Sargasso Sea, you can't help but be touched by moments of the sublime.

One night underwater off Bermuda, photographer David Doubilet was taking pictures of fish attracted to a floodlight on our boat. He circled several flying fish when a large tiger shark was spotted at the periphery of the light. Doubilet was hauled out by his safety line in a hurry.

On repeated outings, we scouted for large mats of sargassum to explore. It was nowhere to be seen. "One day you won't see any at all," an old fisherman told us, "then you wake up the next morning, and the bays and harbors are choked with it."

On other days we had better luck, netting clumps of sargassum and sorting through them in buckets, looking for marine life for photographer David Liittschwager to document. Turning one piece over, I spotted a froggy little creature with a big mouth and weedlike appendages: the sargassum fish, one of more than a dozen organisms that evolved to mimic the seaweed. Using its tiny pectoral fins to cling to the sargassum,

it was all but invisible. Philippe Rouja, a Bermudian marine biologist who was helping us look for creatures living in the weed, dropped another little fish into the bucket. The sargassum fish immediately gulped it down in its large mouth.

That night, I sat with Liittschwager as he photographed the day's bounty. In one soccer-ball-size clump of sargassum, we counted 900 tiny fish larvae, 30 amphipods, 50 snails, four anemones, two flatworms, six crabs, 20 shrimps, seven nudibranchs, more than a thousand calcifying worms, and abundant bryozoans, diminutive copepods, and other planktonic animals almost too numerous to count.

"So," an astonished Liittschwager said after we'd completed the inventory, "the conservative count is 3,000 creatures visible to the naked eye—well, with my reading glasses."

LAPOINTE'S EFFORTS to promote sargassum's virtues to a wider public have been derailed by the weed's explosions in the Gulf, the Caribbean, Brazil, and even West Africa, smothering mangrove habitats, suffocating reefs, choking bays, burying beaches (the mats prevent hatchling turtles from making their way to the open sea), and hurting tourism.

"Too much of a good thing," Lapointe says of the weed blooms—making the water "anoxic and putrid."

During the past several years sargassum washed up on beaches on Martinique and Guadeloupe in piles more than 10 feet high. "I've got people telling me if this doesn't stop, we're going to have to shut down our resorts," Lapointe says. People on Trinidad and other Caribbean islands have been forced to evacuate their homes because of the toxic hydrogen sulfide gas released by the rotting weed on beaches.

No one knows exactly why these blooms happen. Lapointe thinks climate change may be altering ocean currents, carrying sargassum to places it's rarely been seen—from West Africa to the northern coast of Brazil. Another hypothesis is that phosphorus-rich, wind-borne dust from the Sahara that used to be blown across the Atlantic has been settling out at sea, triggering offshore blooms. But the main culprit is likely nitrogen enrichment from industrial farming in the U.S. interior—nutrients flowing from the Mississippi system into the Gulf, causing sargassum to grow rampantly.

"The system is too complex to fully understand," Lapointe said, "but this is what seems to be happening. We're tracking down the nitrogen trail, and it starts in the heartlands."

I need look no farther than out my window in southern Connecticut to be reminded that interconnectedness in nature is not just a New Age platitude borrowed from Eastern philosophy. No creature better exemplifies the holism of nature than freshwater eels. They live in the pond across the street from my house, but guess where they—and every other American eel—were born? In a warm womb a few thousand miles away called the Sargasso Sea. ▯

Artist and writer **James Prosek** is working on a book about ways of naming and ordering the natural world. **David Doubilet** has photographed more than 70 *National Geographic* stories. **David Liittschwager**'s photographs of plankton and plastic appeared in May 2019.

The Sargasso Sea—a Living Laboratory for Change

BY SYLVIA A. EARLE

I CAN ALMOST FEEL the sizzle of energy as sunlight, carbon dioxide, and water work the magic of photosynthesis while I drift, wrapped in a golden curtain of sargassum, just off Bermuda. I revel in the sensation and am thrilled to see tiny bubbles of oxygen, a by-product of photosynthesis, rise to the surface and join the oxygen produced by trillions of diatoms, blue-green bacteria, and other phytoplankton in the surrounding ultraclear water.

As a living laboratory, the Sargasso Sea—with its masses of sargassum and their cargoes of lilliputian creatures—has yielded important findings about how and why the ocean matters to everyone, everywhere, all the time.

It was in 1986 that *Prochlorococcus*—Earth's smallest and most numerous photosynthetic organisms—were discovered in the Sargasso. Now known to occur globally, they churn out as much as 20 percent of the oxygen in the atmosphere. Seaweed and microscopic organisms provide oxygen for life in the sea and more than half the oxygen in the air we breathe. The carbon dioxide they capture is transformed with water into sugar, helping to fuel the complex ocean food webs that culminate in tuna, sharks, whales—and us.

Zoologist William Beebe and engineer Otis Barton, diving in a small submersible in the Sargasso Sea near Bermuda during the 1930s, observed life-forms that exist as much as half a mile deep by day and swim toward the surface at night to feed on phytoplankton, drifting seaweed—and one another. These migrating hordes of small fish and invertebrates, the largest concentrations of animals on Earth, now figure prominently in climate science as "blue carbon"—carbon dioxide captured in the tissues of creatures smaller than the dots on this page and as large as blue whales.

On land, forests also sequester the carbon dioxide that contributes to the planet's warming, but terrestrial environments occupy far less space than the living ocean. In the Sargasso Sea, at least 14 major groups of animals live on or swim among the floating forests of seaweed. Near Bermuda, biologist Laurence Madin has found that many in a single haul of plankton.

For decades, currents in the Sargasso Sea have been assessed, its temperature and water chemistry measured, and its migrating wildlife documented. The findings have shed light on the ocean's role in governing climate and weather, and the processes that underpin our existence.

The Sargasso also bears evidence of harsh human impacts that are occurring globally, from waste dumping to illegal, unreported, and unregulated fishing. In 2010 a coalition working with the Bermuda government formed the Sargasso Sea Alliance, replaced in 2014 by the Sargasso Sea Commission. Our mission: to protect the Sargasso Sea, using it as a model for what can be done regionally, while the UN seeks to protect the ocean globally. ▯

Oceanographer **Sylvia Earle** is a National Geographic explorer-in-residence and co-chaired the Sargasso Sea Alliance steering committee. Founder of Mission Blue and Deep Ocean Exploration and Research, "Her Deepness" has served as chief scientist of NOAA and has logged thousands of hours of undersea exploration.

ABOVE

A school of jacks forage beneath translucent mats of golden weed. Jules Verne, in his 1870 book *Twenty Thousand Leagues Under the Sea,* likened sargassum to a "carpet of weeds."

DAVID DOUBILET

LEFT

Sylvia Earle investigates sargassum off Bermuda during a 2010 expedition as part of her Mission Blue initiative to explore and protect the ocean. "The Sargasso," Earle says, "shines with hope in a troubled ocean."

SHAUL SCHWARZ, GETTY IMAGES

YOUR SHOT

JOBIT GEORGE

PHOTOS FROM OUR COMMUNITY

WHO

George, 26, a freelance photographer in Delhi, India

WHERE

The rooftop of Delhi's famous Jama Masjid mosque

WHAT

A Canon 5D Mark III camera with 85mm lens

During a visit to Delhi's Jama Masjid, one of India's largest mosques, George noticed two individuals among the many awaiting the call to prayer: a father and son, dressed almost identically. In an act as ordinary as the straightening of a cap, George witnessed them sharing "a beautiful moment and bond." Not long after George snapped the photo, the *adhan*—the call to prayer—summoned the father and son away, and George turned his camera to other scenes.

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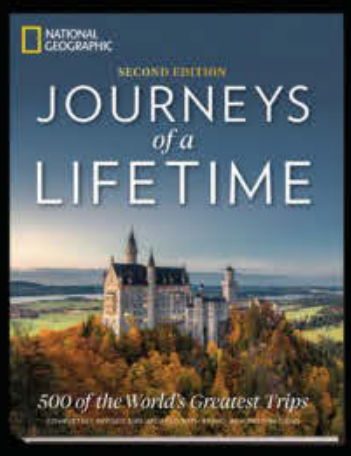

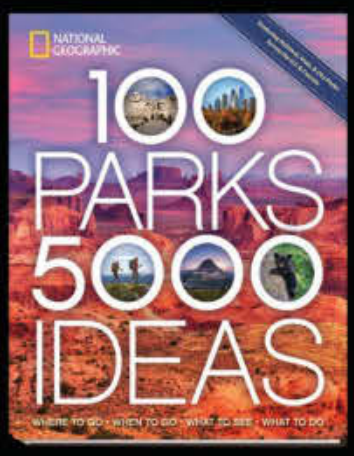

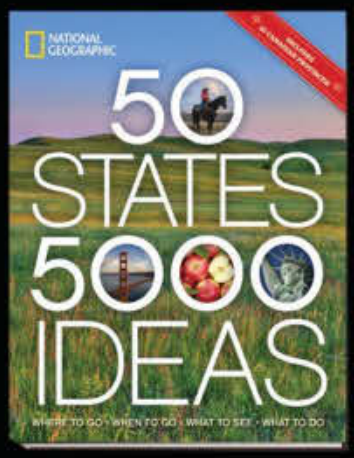

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